PAIGE-DETROIT

REFERENCE BOOK

MODEL

17-20—SIX

SIXTY-SIX

SECOND

EDITION

Paige-Detroit Motor Car Co.

DETROIT, MICHIGAN, U. S. A.

SERVICE DEPARTMENT

Standard Warranty

This is to certify that we, the Paige-Detroit Motor Car Company of Detroit, Mich., warrant each new motor vehicle manufactured by us, whether passenger car or commercial vehicle, to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to making good at our factory any part or parts thereof which shall, within ninety days after delivery of such vehicle to the original purchaser, be returned to us with transportation charges prepaid, and which our examination shall disclose to our satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied, and of all other obligations or liabilities on our part, and we neither assume nor authorize any other person to assume for us any other liability in connection with the sale of our vehicles.

This warranty shall not apply to any vehicle which shall have been repaired or altered outside of our factory in any way so as, in our judgment, to affect its stability or reliability, nor which has been subject to misuse, negligence or accident, nor to any commercial vehicle made by us which shall have been operated at a speed exceeding the factory rated speed, or loaded beyond the factory rated load capacity.

We make no Warranty whatever in respect to tires, rims, ignition apparatus, horns or other signalling devices, starting devices, generators, batteries, speedometers, or other trade accessories, inasmuch as they are usually warranted separately by their respective manufacturers.

PAIGE-DETROIT MOTOR CAR CO.
Detroit, Mich.

Introduction

THE purpose of this book is to assist the owners or operators of Paige Cars in obtaining the best service from their cars and to add to the pleasure of motoring by familiarizing them with the methods by which difficulty may be avoided.

To obtain results it must always be borne in mind that a motor car is a piece of the very finest machinery and that it will render service in proportion to the attention it receives.

Remember that washing the body does not clean the motor; tightening the nuts and bolts that are easily reached does not make those under the car any tighter; oil placed in the motor does not mean that you can neglect the clutch, transmission or rear axle.

We recommend certain things because we have found from experience that they will bring forth the best results. Do not make changes or improvements without consulting us, as there may be strong objections to these changes of which you may not be aware. Remember that we maintain Engineering and Experimental Departments and are in a better position to know what is proper to use or not to use in connection with our cars than the average mechanic, who is apt to try to induce an owner to change some part of the design or install some new device.

We have not taken up the matter of repairs to any great extent in this book. We try to build our cars so that repairs will not be frequent; but should they become necessary through accident, neglect, abuse or other cause, we would advise obtaining the services of the best mechanic in your vicinity. Should he need advice, we would be pleased to have him communicate with us.

For information concerning adjustment of claims, shipment of parts or repairs, address the Service Department, Paige-Detroit Motor Car Company, Fort and Twelfth Sts., Detroit, Mich. Such correspondence will receive our best attention.

Operation

Preparation

When the car is received the motor oil reservoir should be filled through the filler pipe at front of motor until the oil level indicator registers "full." A good grade of medium cylinder oil should be used during both summer and winter months to obtain best results. It is important that all oil be strained before using. A piece of cheese cloth will answer for this purpose.

Know that a good grade of heavy steam cylinder oil, such as 600-W, covers the smallest gear on the countershaft in the transmission. Oil can be entered by removing the floor board and unscrewing the hex-headed plug in the transmission cover. The oil level can be verified by removing the pipe plug in the right side of the case. Oil should reach the level established by that hole and the plug should be replaced before the car is operated.

The filler plug in the cover at the center of the rear axle should be removed and the correct oil level verified. A heavy steam cylinder oil of the same grade as used in the transmission should be poured slowly into the differential housing until it runs out of the filler hole. At that point the level is correct.

The radiator should be filled with clean soft water after the drain cocks at bottom of the radiator, water pump and carburetor are known to have been closed. When filling the radiator the small air relief valve on the thermostat must be opened to prevent possibility of the water becoming air bound in the cylinder block.

Fill the gasoline tank through the filler at rear of the chassis after knowing that the pipe plug in the bottom of the strainer underneath the gasoline tank is in place.

The storage battery located under the driver's seat, should be filled with distilled water or clean rain water to a level which just covers the plates. Should the battery have remained idle for some time, it may be found necessary to have it removed and recharged before the starter is used. For further information on this subject see Page 35.

To Start Motor

It is recommended that the operator become familiar with the action of the gear shift and emergency brake hand levers and with the clutch and service brake pedals before any attempt is made to start the motor. A graphic description of the five gear shift lever positions will be found on Page 9.

Before starting the motor know that the gear shift lever is in the neutral position, then insert the ignition switch key and give it a quarter turn to the left. (Note: The lighting and ignition switch are combined and the movement of the switch to control the lights in no way affects the ignition). The next step will be to advance the throttle control hand lever downward about one-half inch and to advance the spark hand lever about one inch in the same direction. Now pull out the carburetor adjustment on the dash and the motor is ready for starting.

The starting switch is located on the transmission case and the operating button projects through the floor board. This button should be pressed downward with the heel of either foot to start the motor and the pressure should be released the instant an explosion is heard. Should the motor fail to start readily, it would be advisable to locate the cause instead of continuing to operate the starter. The motor should start on a few turns of the starter and the operator's attention is called to the fact that other things being equal, more current can be drawn from the battery by the starter than can be replaced by the generator in over ten times the same length of operating time.

In the event that the vacuum tank has been allowed to stand empty for some time and does not fill readily when the motor is cranked, it is possible that dirt or sediment has become lodged under the flapper valve (H) Figure 17 or that the valves are dry and require priming. In either case the difficulty can be overcome by removing the plug (W) in top of tank and i-

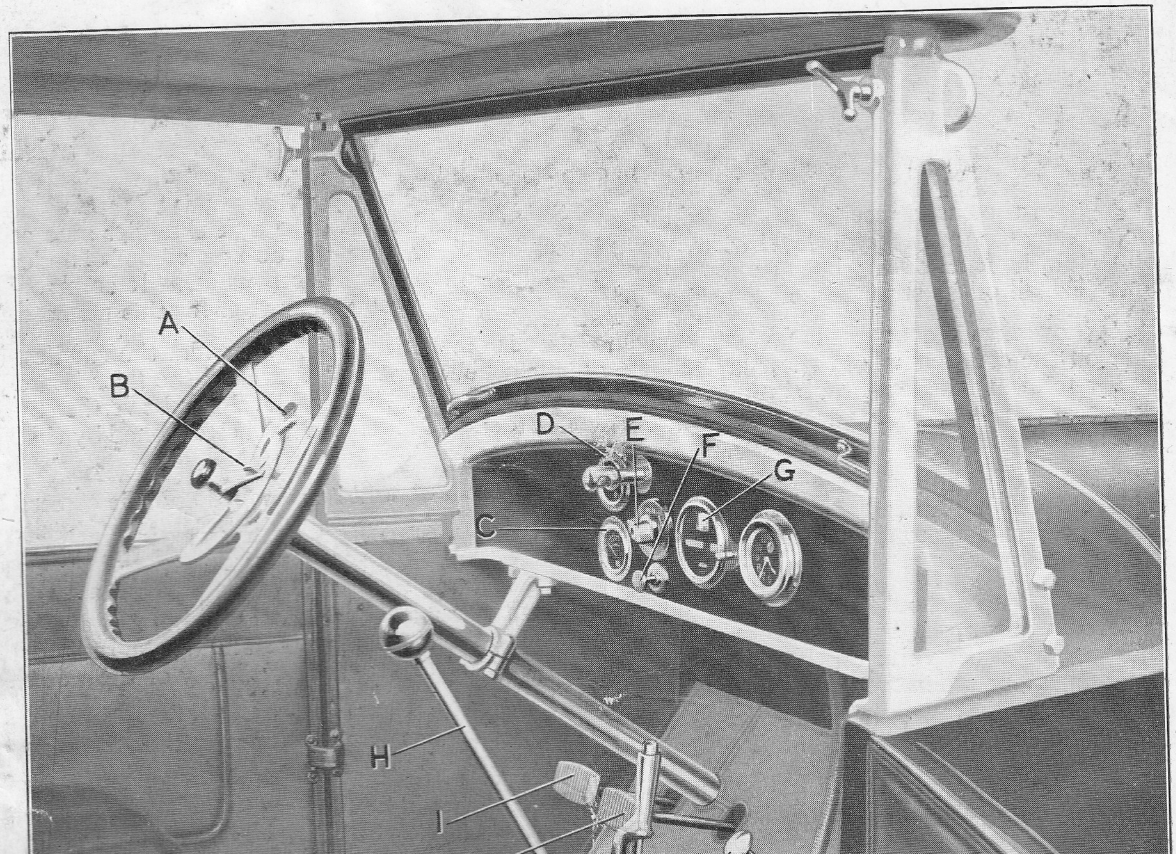


Figure No. 2

FRONT COMPARTMENT

A. THROTTLE CONTROL HAND LEVER
B. SPARK CONTROL HAND LEVER
C. OIL PRESSURE GAUGE
D. AMMETER
E. IGNITION AND LIGHTING SWITCH
F. CARBURETOR DASH CONTROL BUTTON
G. SPEEDOMETER
H. GEAR SHIFT HAND LEVER
I. CLUTCH PEDAL
J. SERVICE BRAKE PEDAL
K. EMERGENCY BRAKE HAND LEVER
L. ACCELERATOR PEDAL
M. STARTER BUTTON
N. GEAR SHIFT LOCK

jecting a small quantity of gasoline into that hole for the purpose of washing away any sediment and to moisten the valves.

When the motor has been started, the carburetor dash adjustment should be pushed downward gradually until the motor is running evenly. Ordinarily the button should be down on its stop and should be pulled out only when starting. After the motor has started, the spark hand lever should be advanced about one-third its travel distance on the sector.

To Drive Car

Before starting the car in motion, adjust the motor to a suitable speed but do not allow it to race. It must, however, be running at a speed sufficient to overcome the inertia of the car without "stalling" the motor when the clutch is engaged. The proper motor speed should be reached when the throttle control hand lever has been advanced about one inch from the fully retarded position. It would be advisable not to use the accelerator pedal until the operator has become familiar with the operation of the car by means of the throttle hand lever.

DIAGRAM OF THE GEAR SHIFT LEVER POSITIONS

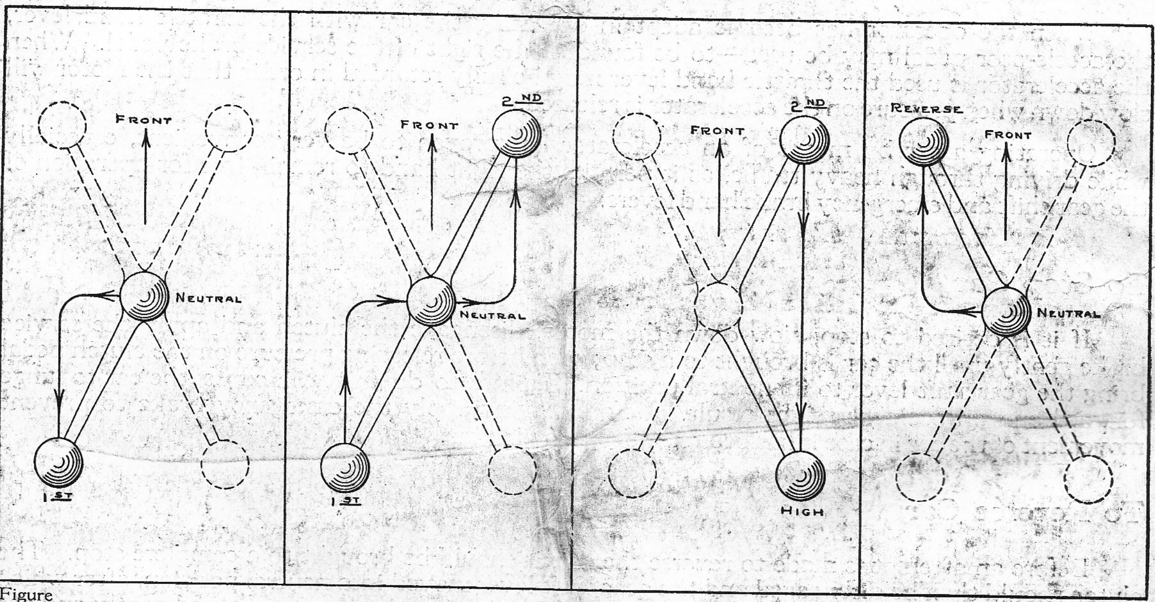


Figure No. 3 First Speed Second Speed Third Speed Reverse

First Speed

Knowing that the emergency brake hand lever has been released, the clutch may be disengaged by pressing downward on the clutch pedal with the left foot, and while holding the clutch disengaged the gear shift lever should be moved from neutral to the first speed position as shown in Figure No. 3, where it will be noted that the movement should be to the left and to the rear.

With the gears meshed for first speed, gradually release the pressure on the clutch pedal and the car will move forward. If operating a car for the first time, it is advisable to drive slowly in first speed for some distance before the change to second speed is made.

Second Speed

When about to change into second speed, the throttle hand lever should be advanced slightly the clutch should then be disengaged as previously explained, and the gear shift lever moved forward to neutral position, then tipped to the right and again forward into second speed. This movement should be practised until the operator can make the change without [illegible]fort a[illegible] wi[illegible]h

sufficient speed to prevent loss of momentum. When the shift into second speed has been made, the pressure on the clutch pedal may be released and the car driven at that speed until the student is confident that the operation can be repeated properly.

Third Speed

When the operator is prepared to change into third speed the throttle hand lever should be further advanced until the car is travelling at a fair rate of speed. The clutch should then be released slightly and the gear shift lever moved directly to the rear, as illustrated, after which the clutch should be re-engaged and the operator's foot allowed to rest lightly upon the pedal in position for an emergency stop. The right foot should rest upon the service brake pedal ready for instant use. At this speed the spark lever may be advanced about one-half its travel distance on the sector and allowed to remain in that position excepting when the car is ascending a grade or under heavy load in which case it should be retarded. The spark lever should always be advanced as fully as possible without causing a "spark knock."

Accelerator

When the operator has become adept in operating the car with the throttle hand lever, the accelerator pedal may be used—to be found at the right of the service brake pedal. When the accelerator is used the throttle hand lever may be fully retarded in order that the motor will slow down when pressure on the accelerator is released.

Operating a car by means of an accelerator has proven to be very convenient, especially while driving through heavy traffic, as it permits the right hand to remain free for operation of the gear shift and emergency brake hand levers.

To Stop Car

If it is desired to stop, slow down the motor, disengage the clutch and apply the service brake gently until the car is brought to a stop; then before releasing pressure on the clutch pedal bring the gear shift lever to its neutral position. Failure to do this will cause the car to lunge forward and an accident might result. Before leaving apply the emergency brake to prevent movement of the car in case it has been stopped on an incline.

To Reverse Car

Before an attempt is made to reverse the car, it should be brought to a complete stop. The clutch should then be disengaged and the gear shift lever moved into neutral position, after which it can be tipped to the left and moved forward. The clutch may then be engaged gently and the motor slightly accelerated.

Emergency Stop

To make an emergency stop, release the clutch and apply the service brake instantly, at the same time exerting the full force of the right arm on the emergency brake hand lever. This should only be necessary in cases of emergency, and the operator should refrain from such practice unnecessarily, as it places an enormous strain on the tires, brakes, and other working parts of the car. **Beware of Attempting a Sudden Stop on Wet Pavements.**

Changing to Lower Speed

In making a change from high to a lower speed while the car is in motion, the clutch must be disengaged and the motor accelerated; otherwise, the car will be running faster than the motor, and even though the operator was successfull in making the change, it might cause serious damage to the transmission. **Changes of this Nature Should not be Attempted when the Car [illegible] Running at High Speed, and Second Speed Should Never be Omitted, as Seric[illegible] is a Probable Result.**

To Stop Motor

When the car has been halted and it is desired to stop the motor, simply turn the ignition switch key into the "off" position.

Caution

Because of its exceptional power and flexibility there may be a tendency to operate the motor at a speed which is prohibitive until such time as the closely fitted bearing surfaces and other working parts have been allowed to adapt themselves to the conditions under which they operate. **A new motor should not be driven at a speed over an equivalent road speed of twenty-five miles per hour for the first thousand miles** at least, as there is a danger of the pistons and bearings becoming badly damaged by seizure as a result of their expansion from overheating caused by friction.

Description

Motor

For the information of the owner or operator, to whom the construction and operation of a gas engine appears more or less complicated, it should be explained that the model 17-20 engine is of the four cycle principle where one explosion occurs in each cylinder to every two revolutions

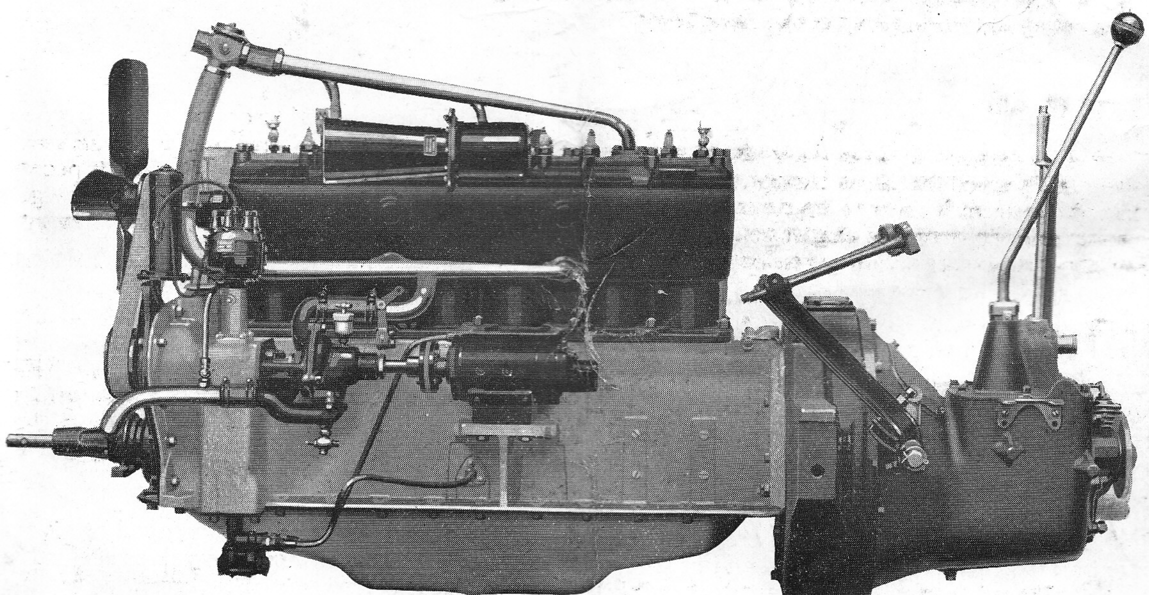


Figure No. 4 POWER PLANT (Left Side)

of the crankshaft, or to each four strokes of a piston. The upward and downward movement of the pistons within the cylinders is controlled by a crank shaft to which they are attached by connecting rods and piston pins. The full movement of a piston in either direction is five inches and is called a "Stroke." These strokes are named in the order in which they occur; namely, Suction Stroke, Compression Stroke, Firing Stroke and Exhaust Stroke.

There are two valves in conjunction with each cylinder. One is called the Intake Valve and the other the Exhaust Valve. These valves are for the purpose of opening and closing passages between the intake and exhaust manifolds and the cylinder. They are caused to open by the action of eccentrics or cams on the cam shaft, the latter being driven by the crankshaft through the medium of gears on the front ends of these shafts and a connecting gear [illegible] n Idler

Gear. The relative positions of the pistons, valves and cams, in their function of admitting fresh gas to the cylinders and expelling the burned gases, determines what is known as the "Valve Timing" of a motor.

Suction Stroke

If the crankshaft is revolved until the first explosion occurs, the action which takes place is as follows: Upon the suction stroke of the piston, the intake valve is mechanically opened, and as the piston moves downward, gas is caused to rush from the carburetor by a partial vacuum created by the increasing space between the top of the piston and the head of the cylinder. The exhaust valve is closed at this time.

Compression Stroke

At the end of the suction stroke, the piston starts upward. Both valves are closed at this time, and the gas is compressed into a small space, making it highly explosive. When the end of this stroke is reached, and just as the piston starts downward again the compressed gas is ignited by means of an electric spark, which takes place between the points (electrodes) of a spark plug screwed into the cylinder head.

Firing Stroke

The ignition of the gas causes an expansion or explosion, which drives the piston rapidly downward, at the same time imparting movement to the other pistons which are attached to the same crankshaft. Both valves remain closed during this stroke.

Exhaust Stroke

The next stroke is upward, at which time the exhaust valve is caused to open and the burned gas is expelled by the piston through the exhaust manifold and muffler into the open air.

Firing Order

These strokes follow each other in the manner shown, as long as the motor is in motion. Exactly the same series of actions are occurring in all six cylinders, but they are so timed that an explosion occurs in only one cylinder at a time in the firing order of 1, 5, 3, 6, 2, 4—No. 1 cylinder being at front of block. There being six cylinders, three explosions occur on each revolution of the crankshaft and they are spaced exactly one-third of a revolution, or 120 degrees, apart. A fly wheel attached to a flange at rear end of the crankshaft is for the purpose of giving momentum to the shaft and to smooth over the lapses between explosions.

Cylinders

The cylinders of this motor are of special grade iron cast en bloc and are arranged to give a maximum of water jacketing and an unusual amount of cooling space around the valves and valve seats. A detachable head adds to accessibility, permitting the removal of carbon without the necessity of removing the entire cylinder casting and simplifying the work of valve grinding. The gas intake manifold is of the conventional Hot Spot design, and supplies sufficient heat, derived from the exhaust manifold, to assist in the proper vaporization of low grade gasoline now in use. The exhaust manifold is cast integral with the intake manifold and is provided with a gland and asbestos packing ring for exhaust pipe connection.

Crankcase

The crankcase is of aluminum metal and its rear end is drilled and tapped for the attachment of a housing which incloses the flywheel and clutch. Two arms cast integral with this housing provide the means of the motor rear support. The front end of the crankcase is flanged and drilled for the attachment of a cast iron cover which incloses the timing gears and provides a trunnion for motor front support. The housing for the starting crank shaft is fastened to this

trunnion, thereby permitting its removal independently of the gear cover. A breather for the release of gas in the crank case is provided at the rear of the cylinder block. It consists of a re-enforced leather flap hinged at the side where its dust proof cover is attached.

Crankshaft

The crankshaft is mounted in four bearings of bronze backed babbit lined construction, which are supported in the heavily ribbed and re-enforced crank case. These bearings are in halves, each upper part being attached to one of the four webs in the crank case, and the lower part to an aluminum cap; the caps for the end bearings being secured to the webbing by four studs through each and for the center bearings by two studs through each. Plain washers are used and castellated nuts are secured by cotter keys. Laminated shims are installed between the bearing halves to save time and labor and to increase accuracy in adjusting the bearings for wear. The material used is Laminum, which is made of many layers of hard brass held together

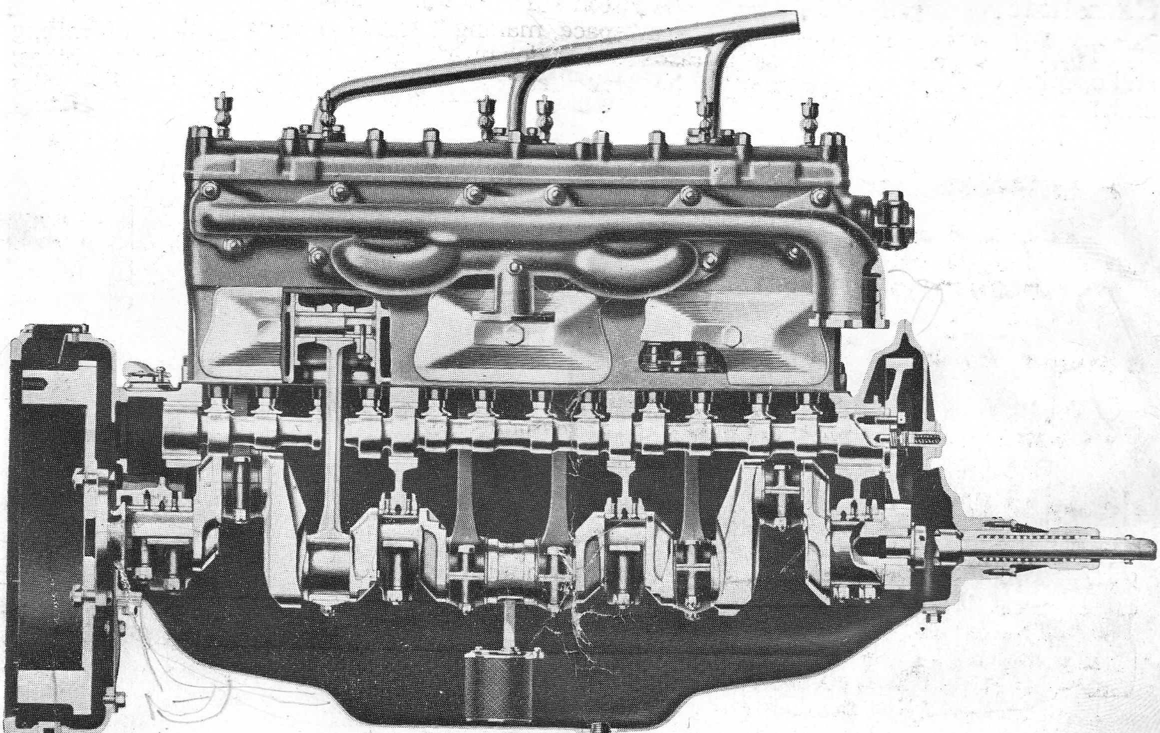


Figure No. 5 SECTIONAL VIEW OF MOTOR (Right Side)

by a metallic binder like solder and compressed into a solid shim. The layers can be pulled off the shim with a knife blade easily and quickly, leaving a glassy surface. The crankshaft bearings are easily accessible when the oil pan has been removed.

The allowance for thrust or end play in the crankshaft to allow for expansion, is five thousandths of an inch. Any thrust which may develop over that amount can be reduced by removing one or more steel shims between a shoulder and the gear on front end of the shaft. These shims are four and eight thousandths of an inch in thickness.

Connecting Rods

The connecting rods are also provided with bronze shell babbit lined bearings which are clamped to the arms of the crankshaft by heavy caps. The caps are secured by two nickle steel bolts through each and locked by castle nuts and cotter keys. Laminated shims are installed between halves to provide for their adjustment. These bearings, as well as the crankshaft bearings, are prevented from turning by two brass screws in each half. The upper end [illegible] the co[illegible]ect-

ing rods are provided with bronze bushings and are attached to the pistons by hollow pins of hardened steel. These pins are secured to one boss in each piston by extra long set screws, which enter an anchor block or lock nut set into one end of the pin, thus preventing movement of the latter. The screws are locked by soft steel washers turned up on one side and banked against the inside of the piston to prevent turning.

Pistons

Each piston is equipped with three compression rings of the diagonal cut type, and these rings, as well as the pistons, are carefully fitted to provide a proper clearance for expansion. A groove is cut into the lower outside edge of the lowest ring groove to provide a trap for surplus oil. The pistons are ventilated with twelve holes through the bottom of that ring groove for the return of oil to the reservoir.

Camshaft

The camshaft, upon which twelve cams or eccentrics are forged (for the durpose of raising and opening the valves), is mounted at the right side of the crankcase in four die cast bushings, and is driven at half crankshaft speed—through a helical gear on its front end—by an idler gear, which in turn is driven by the gear on crank shaft.

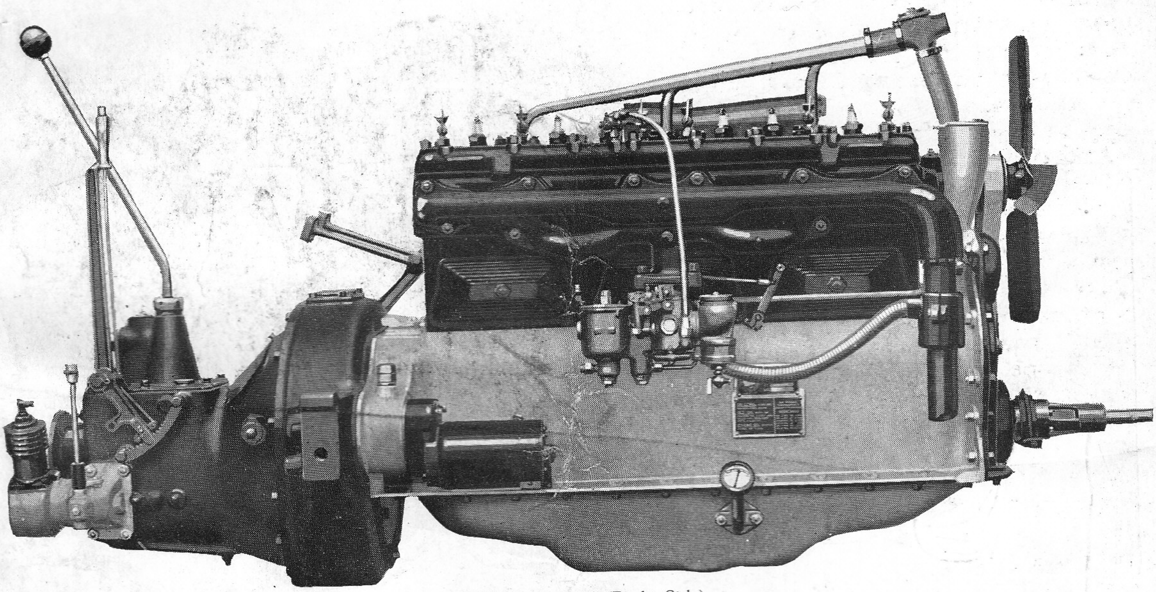


Figure No. 6 POWER PLANT (Right Side)

The idler gear is made of special material to insure quietness. The camshaft bushings are prevented from turning by brass dowels entered from the top face of the crankcase. End play in the camshaft and idler gear shaft is provided for by thrust buttons pressed into holes in their front ends. Adjusting screws are entered through the timing gear case cover and hardened steel plungers backed by coil springs are retained on the inner ends of the adjusting screws.

The adjusting screws in the timing gear case cover are properly regulated to provide for the thrust of the camshaft and idler gear shaft, and should not be disturbed unless a knock has developed as a result of excessive end play. To regulate these screws, the lock nuts must be released and the screws tightened against the ends of the shafts. When a tension is felt, the screws should be backed off one-half turn and the lock nuts retightened.

Valves and Tappets

The valves are inclosed at the right side of the cylinder block and are lifted by tappets of the mushroom head type, which are in turn lifted by the eccentrics on the camshaft. Helical springs

for the purpose of closing the valves are held partially compressed between shoulders near the upper ends of the valve guides and retainers at the lower ends of the valve stems. These retainers are held by horse shoe washers in grooves around the stems, and the washers are in turn locked in position by the retainers. Hexagon headed screws with their lock nuts are threaded into the upper ends of the tappets and are adjusted to allow a proper clearance between their heads and the lower ends of the valve stems, in order that the valves may close completely and prevent loss of compression.

Bearing Adjustment

A motor knock is always a herald of trouble, and among those conditions which might cause its development are loose crank shaft and connecting rod bearings. Only experience can make one proficient in locating a knock, and the noise produced by a loose bearing is especially difficult to identify and locate, inasmuch as the sound varies according to differences in conditions; usually however, a crankshaft bearing knock takes the form of a dull pounding or thump, while a connecting rod bearing or piston pin bushing knock is more sharp and higher in pitch.

Where a knock has developed in the crankshaft or connecting rod bearings, it will usually be found necessary to remove the oil pan and reduce the thickness of the shims between the upper and lower halves to compensate for wear. These shims, as before stated, are of laminated section and so constructed that one or more laminations can be separated from the shims to reduce their thickness. When the bearings have become worn beyond the possible limits of adjustment, and in cases where they have seized from lack of sufficient lubrication, or are otherwise damaged, it will be necessary to effect their replacement. This is also true where sufficient wear has occurred on the piston pins or their bushings to cause a knock, as no means of adjustment is provided at those points. In any event, while any of the above mentioned operations may be simple for the experienced mechanic, they are extremely difficult for the novice, and it is recommended that the car be placed in the hands of an expert in a properly equipped repair shop.

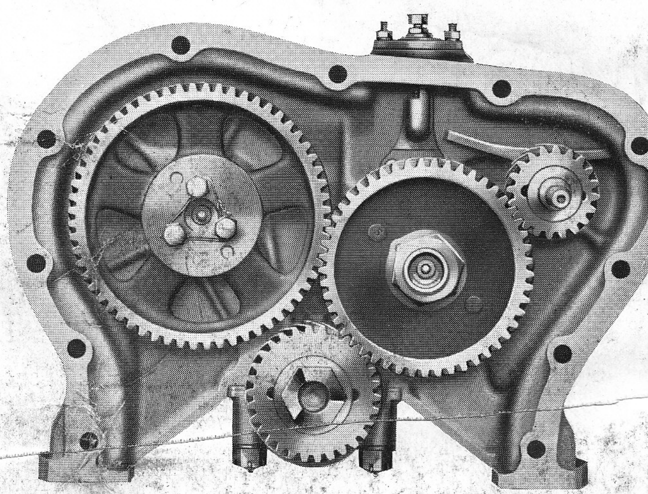


Figure No. 7 FRONT END OF MOTOR
(Showing Timing Gears and Oil Pressure Regulator)

Valve Timing

Excepting in the case of a major repairing operation, when the motor is completely dismantled, there should be no occasion for disturbing the relative position of the gears on the crank, cam and pump shafts or the idler gear, by which the opening and closing of the valves and the occurrence of the spark at the proper time is controlled. However, should circumstances necessitate their removal, it is a simple matter to re-establish their proper relation by giving attention to the marks punched upon the face of the gears, as shown in Figure No. 9. The position of the gears on the crankshaft and camshaft are, of course, very important, and to eliminate possibility of mistake, one of the three holes in the gear and in the end of the camshaft for the capscrews, is drilled slightly out of line with the others. Therefore, the gear has only one position on the shaft. The position of the crankshaft and pump shaft gears is controlled by the keyway.

For the information of those concerned in the timing of the valves beyond the mechanical operation of meshing the gears at the proper point, it is shown in Figure No. 9 that the intake valve opens twelve degrees crank travel after top dead center, the equivalent of $\frac{5}{64}''$ pist travel or $1\frac{21}{32}''$ on the $15\frac{13}{16}''$ diameter of the flywheel and that it closes forty degrees cra travel after bottom dead center, the equivalent of $\frac{15}{32}''$ piston travel or $5\frac{33}{64}''$ on the 15 diameter of the flywheel. The exhaust valves open forty degrees crank travel before botto dead center, the equivalent of $\frac{15}{32}''$ piston travel or $5\frac{33}{64}''$ on the $15\frac{13}{16}''$ diameter of the flywh

and close eight degrees crank travel after top dead center, the equivalent of $\frac{3}{64}''$ piston travel or $1\frac{7}{64}''$ on the fifteen inch diameter of the flywheel.

The rim of the flywheel is marked with a line and the letters "DC" at one point in its diameter, and at a point 12 degrees distant with a similar line and the symbols "No. 1-EC." When the line "DC" is opposite the pointer at the opening in the flywheel housing, number one and number six pistons are at the top dead center position. One of them will be at the top of its intake stroke, however, and about to start its firing stroke, while the other will be at the top of its exhaust stroke and about to start its suction stroke. When the line "No. 1-EC" is opposite the pointer, the exhaust valve for the cylinder about to start its suction stoke, has just closed.

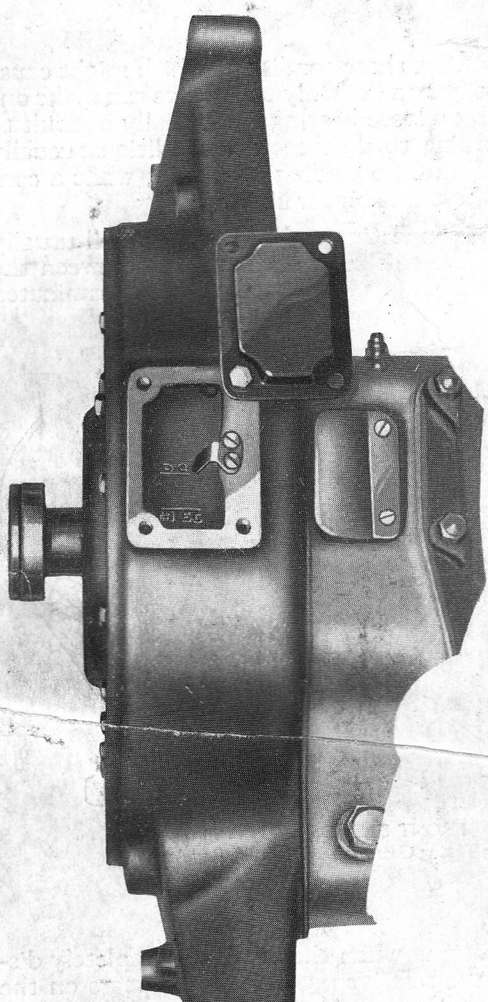


Figure No. 8

TIMING MARKS ON FLYWHEEL

Valve Adjustment

In order that the valves may close entirely to prevent loss of compression, it is necessary that there be a clearance between the bottom of the valve stems and the tappets of not less than four thousandths (.004) of an inch when the motor is warm. This distance can be regulated by means of the adjusting screws in the upper ends of the tappets. If the motor is cold at the time of adjustment, the clearance should be not less than five thousandths (.005) of an inch. After the motor has become warm, this setting will give a proper running clearance.

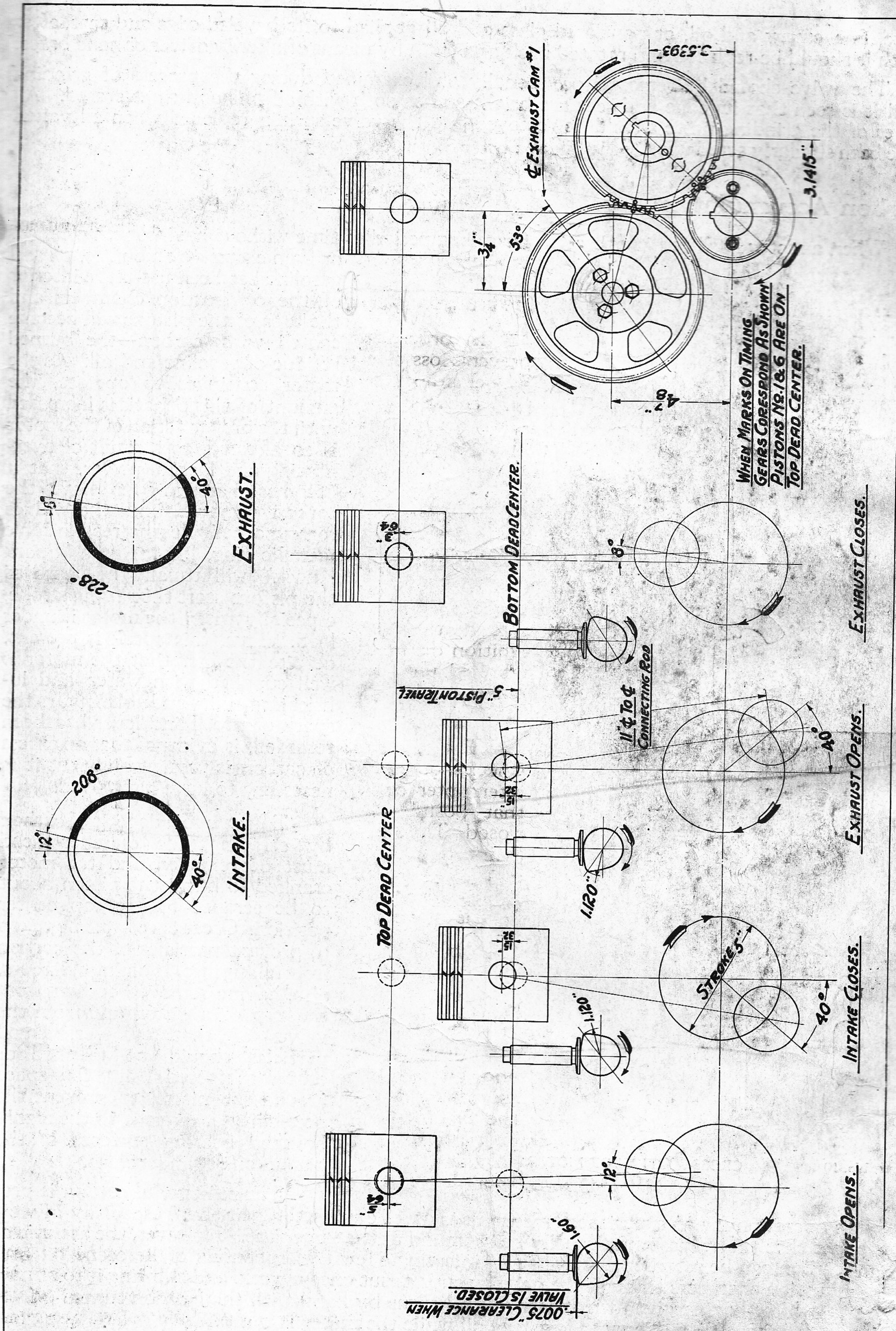
In order that the novice may know that the tappets being adjusted are resting upon the lowest side of the eccentric on camshaft, the top of the ignition distributor should be removed and the motor cranked until the distributor block is in position to make contact with the high tension cable leading to No. 6 cylinder, as shown in Figure No. 14.

The spark control hand lever at the steering wheel should be in the fully retarded position and the interrupter contact points in the act of opening. At that position both valves in No. 6 cylinder are closed. The valves of No. 2 cylinder would be next in line for adjustment by causing the distributor block to pass to the next segment in the distributor. The valves for cylinders Nos. 4, 1, 5 and 3 would follow in the order in which they are given, the clearance being measured with a shim known to have a thickness of exactly five thousandths (.005) of an inch.

Grinding Valves

Although the bevelled valves are carefully fitted and ground to a perfect seat when the motor is assembled, to prevent the escape of gas during the the period of its compression and expansion after ignition, it will be found after sometime that particles of carbon have become lodged between the valves and their seats and that an accumulation of such particles, together with the natural deposit, has badly pitted the seating surfaces and is preventing the valves from closing properly.

When valves are reground after the head of the cylinder block and other interfering parts been removed, a covering should be placed over the cylinders to exclude dirt and other substances which might accidentally fall into them. The cover plates on the right side cylinder block must also be removed, and the valve springs compressed to release the d locking washers. With the springs removed, the motor should be cranked to lve about to be ground. It should then be removed and a good valve grinding



VALVE TIMING DIAGRAM

Figur

paste, fine emery and oil, or powdered glass and oil applied to its beveled edge and seat, after which it should be replaced and rotated back and forth by means of a screw driver or hand brace.

The valve should be removed occasionally and examined during the process of grinding until it is seen that its edge and seat are bright and smooth with all pits and rings erased. All traces of the grinding paste should be removed and the valve springs replaced when all valves have been similarly acted upon.

Carbon Accumulation

When a motor has been in operation for a long period of time without having been cleaned, or if an excessive amount of oil and gasoline has been used, the interior of the combustion chambers and the tops of the pistons will become coated with carbon—the burned residue of gasoline and oil. As the motor continues to operate, the amount of this deposit is increased until the proper action of the motor is so affected, as a result of over-heating and lack of power, that it becomes necessary to have the carbon removed and the valves reground. A clearly recognizable metallic ring, known as a "Spark Knock" will usually be heard as the pistons start their firing stroke, especially when the motor is under load. That this spark is present, despite the fact that the motor is well supplied with water and lubricating oil, and although the spark control hand lever has been retarded, is evidence that an excess of carbon is present and that it is necessary to have it removed.

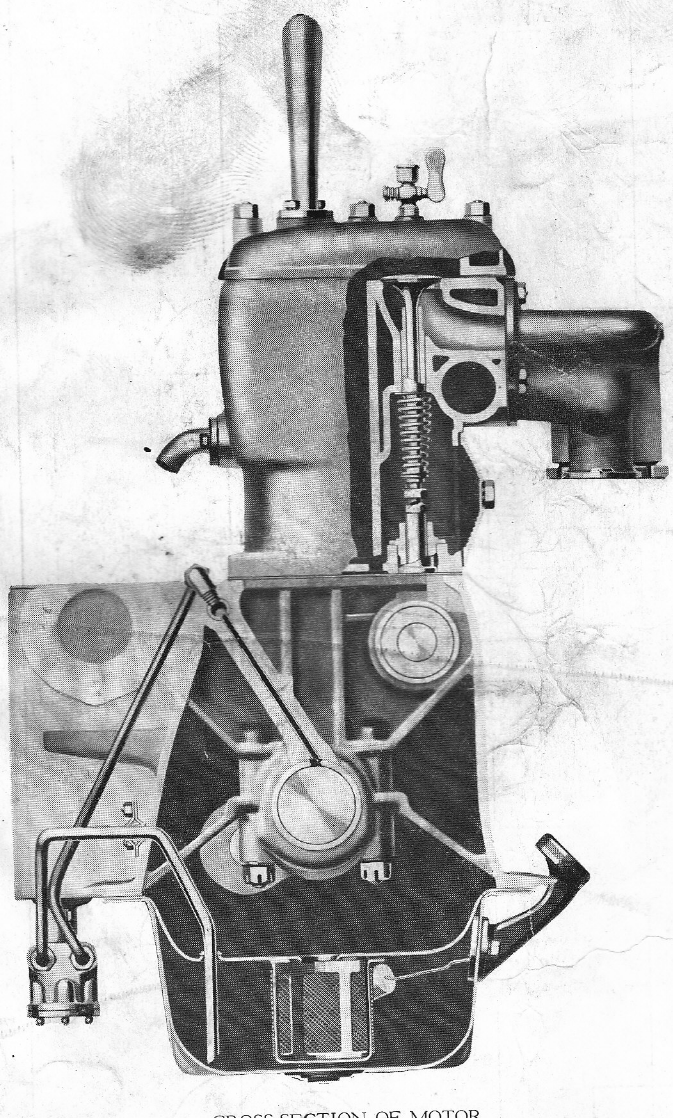


Figure No. 10 CROSS-SECTION OF MOTOR (Showing Oil Passages)

To remove a deposit of carbon by scraping, the cylinder head must be removed and the motor cranked to bring the piston about to be scraped to the top center position. Great care must be taken to prevent particles of the carbon from falling into adjoining cylinders, also, having removed carbon from the top of a piston and from the valves of that cylinder, small particles should be brushed or otherwise forced from the space around the piston to prevent the possibility of damage to the highly polished bearing surfaces of the pistons and cylinder walls.

The removal of carbon is pro-...erly an operation for an experienced mechanic in a well equipped repair shop, especially in view ...e fact that the valves must usually be reground at the same time. However, the accumulation of carbon can be retarded somewhat by injecting a few tablespoonfuls of kerosene oil into ...nbustion chambers through the priming cups about once a week, and allowing it to remain a... ...ugh after having given the motor several turns by hand with the ignition turned off. It m... it ...cially beneficial to inject the kerosene oil while the motor is warm.

Lubrication

The crankshaft bearings, connecting rod bearings and timing gears are lubricated by pressure feed from an exposed gear pump which is attached below a shoulder at the front end of the crankcase where it is accessible and subjected to the maximum cooling effect by air drawn through the radiator. The vertical pump shaft is driven by the water pump shaft through the medium of a worm and gear. The oil pump shaft has bearing in the top of the crankcase and extends through the case for connection to the ignition distributor shaft.

The oil is drawn from the reservoir through a copper tube which projects through a sub-pan and extends in the opposite direction through the side wall of the crankcase to the intake side of the pump. From there the oil is forced through another tube to the upper edge of the crankcase where it enters into a gallery passage extending the full length of the case. From this passage the oil is forced to each of the four main bearings through separate passages cast in the webbing

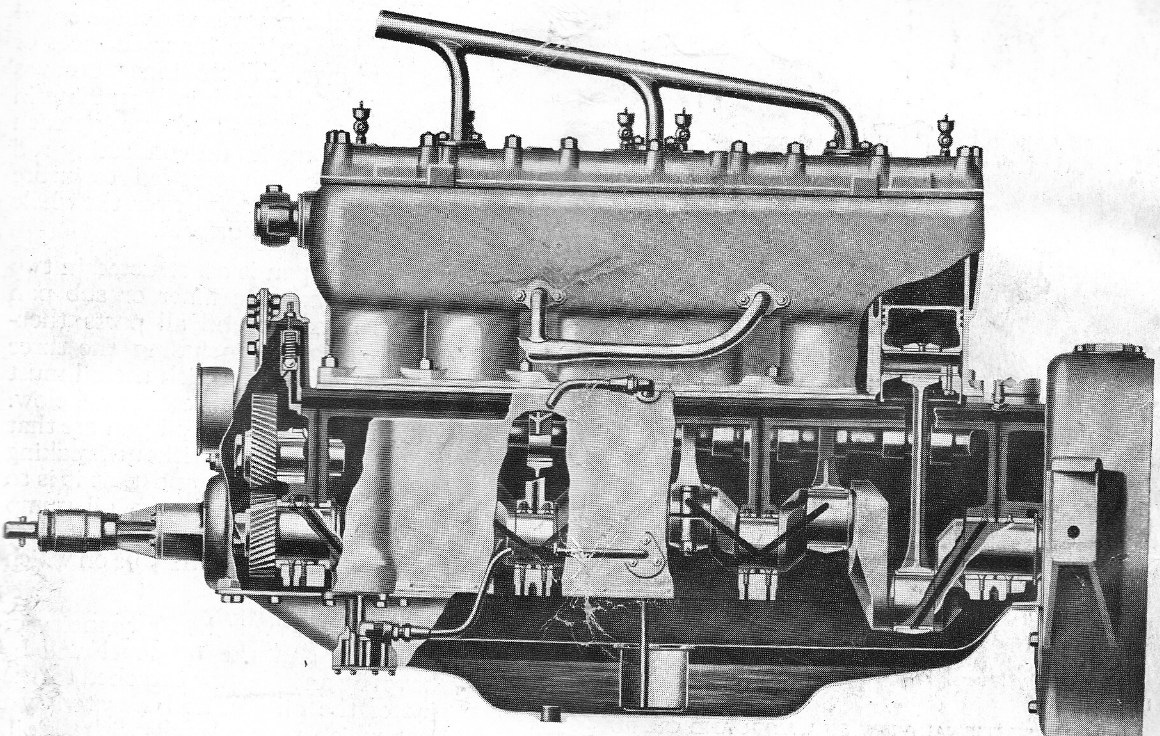


Figure No. 11

SECTIONAL VIEW OF MOTOR
(Showing System of Lubrication)

which supports the bearings. The gallery passage and the four passages or ducts leading to the main bearings are lined with steel tubing to prevent oil seepage. Passages are drilled in the crankshaft and oil is thereby conducted from the main bearings to the adjacent connecting rod bearings.

Plugs of bearing metal are dovetailed into the laminated shims of both the main and connecting rod bearings. These plugs are located at each end of the shims and extend between the bearing halves for the purpose of preventing oil from escaping from the bearings at the shim opening. This feature assists in maintaining a proper pressure in the oil line.

The rear end of the gallery passage is closed by a pipe plug, while the front end opens into a[illegible] oil relief valve attached to the front end of the crankcase within the timing gear compartm[illegible] Two small holes drilled in the body of this valve supply oil for lubrication of the timing [illegible] The overflow caused by any excess pressure in the line, which has outlet through a larger [illegible] near top of the valve body, is an additional source of timing gear lubrication. The [illegible] lie[illegible] extends through the top of the gear case where a set screw is provided under a cover, fo[illegible] gu[illegible]

of the oil pressure. This regulator will have been set to give a proper pressure, and that setting should not be changed excepting for extreme differences in climate or changes in the oil from the standard medium grade recommended for summer and winter use. Differences in the viscoscity of the oil being used, changes in the temperature of the motor, the speed at which it is being operated and the extent to which the bearings have become worn, all have their effect on the oil pressure, and it will be found to vary several pounds either way from the basic setting of fifteen pounds at an engine speed of one thousand revolutions per minute when the oil is warm.

As the oil is forced out around the main and connecting rod bearings, it is whirled into a spray, which reaches every corner of the crankcase and provides lubrication for the piston pin bushings, cylinder walls and camshaft bearings as well as the valve mechanism. Pockets have been formed in the crankcase over each of the camshaft bushings, the pump shaft bushing and the bushing for idler gear shaft. Oil is caught therein and is drained through holes to each of these bushings. A hole is drilled into the upper end of each connecting rod to intercept annular grooves turned on the outside of the piston pin bushings. Holes equally spaced are drilled into these annular grooves and meet spiral oil grooves on the inner surfaces of the bushings. These inner grooves are a part of two spirals running in opposite directions and crossing each other. The main and connecting rod bearings are also grooved to insure distribution of the oil over the whole of those bearing surfaces.

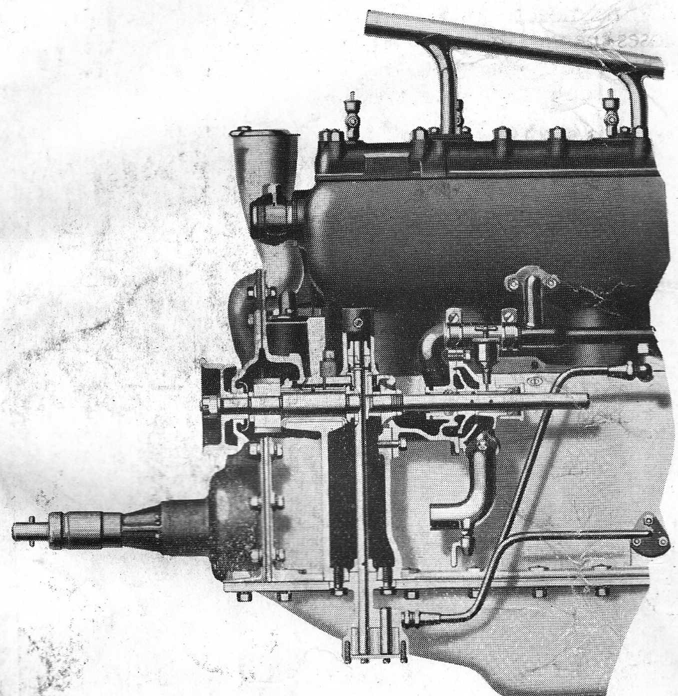


Figure No. 12

SECTIONAL VIEW OF WATER AND OIL PUMPS

The oil pan is constructed in two pieces so that the inner or sub pan can be removed and all parts thoroughly cleaned, including the three strainers through which the oil must pass to enter the reservoir below. Other features of this oil pan are that it can be removed without breaking any oil connections, and that it is so arranged as to enable the oil pump to continue drawing oil, no matter how steep the grade may be on which the car is operated.

The reservoir has a capacity of 8 quarts, and the oil level will be shown by an indicator attached to the side of the oil pan and operated by a float which rises and falls with the oil.

Cooling System

The heat generated by explosions within the cylinders would in a short time cause serious damage to the cylinder walls and pistons were they not cooled by artificial means. This is accomplished with the model 17-20 motor by the circulation of water around the cylinders, which absorbs the heat and carries it to a radiator, where it is diffused by falling through a series of zig-zag passages past which cool air is drawn by a fan. The forced circulation system is used, whereby the water is carried from a tank at bottom of the radiator through a connecting pipe into a centrifugal pump mounted on the left side of the crankcase. From this pump the water is forced into the side of the cylinders and returns to a tank at top of the radiator through a connecting pipe attached to the cylinder head.

The pump vane which operates within the pump housing and impels the water from the radiator into the water compartment of the cylinder block, is keyed to the horizontal shaft which is coupled to the generator. The front end of this shaft is mounted in two bronze backed bushings in the crankcase, and its gear is engaged with the idler gear in the compartment at front of the crankcase. The pump shaft is adjusted for end play in the same manner as the crankshaft, by several shims between a shoulder on the shaft and the gear on its front end. These shims

are two and eight thousandths of an inch in thickness and may be removed or added to allow about four thousandths of an inch end play for expansion. The rear end of the shaft is supported within the pump body by a bronze bushing, and bronze packing nuts have been provided at each end of the body to prevent leakage of water around the shaft. The front packing nut has a right hand thread while the rear nut has a left hand thread to prevent loosening by friction of the shaft.

Thermostatic Control

Thermostatic regulation of water temperature provides for quick starting and efficient engine operation. When water in the motor is cold the main valve is closed, thereby preventing circulation through the motor block. This permits the temperature of the motor to rise to the point of maximum efficiency within a few moments in the coldest weather. The pump pressure is relieved by by-passing the water from the delivery end of the pump through a by-pass valve in the thermostat, thence into the radiator. Complete circulation of water through the radiator is thus maintained at all times. When water in the motor block reaches a temperature of 170 degrees, its action upon a diaphram in the thermostat causes the latter to expand and gradually open the main valve. This action also closes the valve of the by-pass connection. The diaphram is sensitive to any variation of water temperature and will open or close the main valve as required. In this manner a constant even motor temperature is maintained.

The small valve on the thermostat is simply an air relief. When filling the cooling system this must be opened to prevent possibility of the water becoming air bound in the cylinder block.

Ordinarily the thermostat will continue to function during the life of the motor with no attention. There is no chance that it will in any way impair the cooling efficiency of the motor. Its design is such that the main valve will immediately open and permit normal water circulation, should the diaphram ever become punctured. In case of failure, return the instrument to the Beneke & Kropf Mfg. Co., 21st and Rockwell Sts., Chicago, Ill., or to their nearest branch or service station, for replacement.

The complete cooling system has a capacity of six gallons, and can be drained by opening the pet cocks beneath the radiator and water pump.

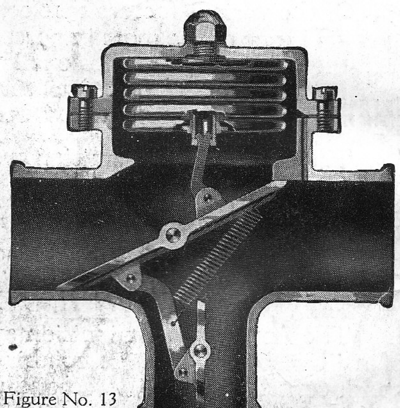


Figure No. 13

RAYFIELD THERMOSTAT
(Interior View)

Fan Adjustment

Overheating is oftentimes due to a slipping fan belt, and it is recommended that this be among the first points investigated. The tension of the belt can be regulated by loosening the cap screw in the fan bracket, where it is clamped to a stud at front end of the cylinder block.

Anti-Freezing Solution

In extremely cold weather, a water cooled engine must be carefully guarded against freezing. Should the water freeze in any part of the system, there is every probability that serious damage will be caused to the radiator and motor cylinders by the internal pressures. When the car is not in operation during cold weather, the safest procedure is to drain all water from the cooling system by opening the drain cocks beneath the water pump and the radiator. In any event, it is recommended that an anti-freeze solution be used as it is not an uncommon occurrence for the water to freeze while the vehicle is in operation, especially if the lower portion of the radiator is uncovered.

For a temperature not lower than 5 degrees below zero, the following mixture should be used:

Denatured Alcohol	15 per cent
Glycerine	15 per cent
Water	70 per cent

For a temperature not lower than 15 degrees below zero, use:

Denatured Alcohol	17 per cent
Glycerine	17 per c[illegible]
Water	66 per [illegible]

For temperatures below 15 degrees, it is recommended that more alcohol be added in proper proportions. Alcohol should also be added to any solution periodically to replace that lost by evaporization. The glycerine does not evaporate.

In the event that glycerine cannot be obtained, a solution of 30 percentum alochol and 70 percentum water can be used. The boiling point of this solution is lower than the glycerine-alcohol solution and new alcohol must be added frequently to replace that lost by evaporization. It is advisable to test any solution occasionally by drawing a small quantity and allowing it to stand in the cold. If it thickens, new alcohol should be added.

Should the radiator become frozen, the motor must not be operated until full circulation has been started. It is impossible to thaw a frozen radiator by running the motor in a cold temperature, whereas by doing so, the current of cold air drawn through by the fan may cause it to freeze more solidly.

IGNITION

Explanation

Of the various factors that combine to produce the efficiency of internal combustion engines, ignition is one of the most important, and it is believed that every operator should at least understand the general principles employed in the construction and operation of that system, in order that he may be able to differentiate between faulty ignition and the difficulties which are oftentimes similar in effect but due to other causes.

The function of an ignition system is to produce a single hot spark at the points or electrodes of the spark plugs for each power impulse of the motor, accurately timed to occur at exactly the right instant to produce the greatest possible power and efficiency.

Construction and Operation

The Atwater-Kent ignition system receives its current from a storage battery and consists of a "Unisparker" which combines a contact maker, condenser, distributor and an automatic spark control feature. A second unit known as a "Coil" has a resistance unit located in its top and is simply an iron core with primary and secondary windings sealed in an insulating tube. The purpose of the coil is to transform the low voltage primary current, supplied to it by the contact maker, into high voltage secondary current required to jump the spark plug gap.

The contact maker consists of a light steel contact arm with composition fibre tip, the end of which rests on a hardened steel cam at the upper end of the unisparker shaft, the latter being coupled to the oil pump drive shaft and caused to rotate at one-half engine speed. This cam has six sides corresponding to the six cylinders, and each time the contact points are opened by the cam a spark is produced at the proper plug.

The condenser is mounted on the contact maker and serves as an electrical shock absorber, preventing burning of the contact points. If not tampered with it will last indefinitely.

The distributor forms the cover of the contact maker. Its central electrode receives the high tension current from the coil and passes it to a rotating distributor block, which just clears the distributor points at the terminals of the wires to spark plugs without actually touching them and distributes the current to the plugs in proper firing order.

Automatic Advance

When an engine is run at high speed, the piston beginning at the bottom of the compression stroke reaches the top in a short space of time, and as the vapors are slow burning, it is necessary [illegible] them well in advance of the time when the piston reaches the top of its stroke, in order [illegible] full effective pressure may be exerted on the area of the piston head when it has started [illegible] next [illegible] downward stroke. If the spark should be too far advanced, the full effective [illegible] the explosive forces would be exerted against the piston before it reached the top of [illegible] there would be a tendency to force the piston downward again or to cause it to [illegible] the [illegible] momentum of the flywheel. The engine, however, would continue to turn over [illegible] by [illegible]

but the bearing pressure would be greatly increased. It is this advance in spark that causes a "spark knock". The actual sound or knock is caused by the piston being forced from one side of the cylinder to the other when the angularity of the connecting rod changes at the top of the stroke. If the spark is too far retarded for the speed of the motor, the maximum effect of combustion is exerted so long after the piston passes its highest point that some of the energy is wasted, and not being applied mechanically tends to overheat the motor.

The automatic advance feature, consisting of a centrifugal governor mechanism; located in the base of the contact maker, is so constructed that the six sided cam in the breaker mechanism is automatically advanced or retarded by the action of centrigufal force on the governor weights, as the motor speed is increased or decreased. The proper manipulation of the spark hand lever at the steering wheel to produce the highest efficiency from the motor is not always fully understood, and the automatic advance feature should relieve the operator of attention to the movement of that lever during changes in speed within the ordinary driving range. However, the unisparker

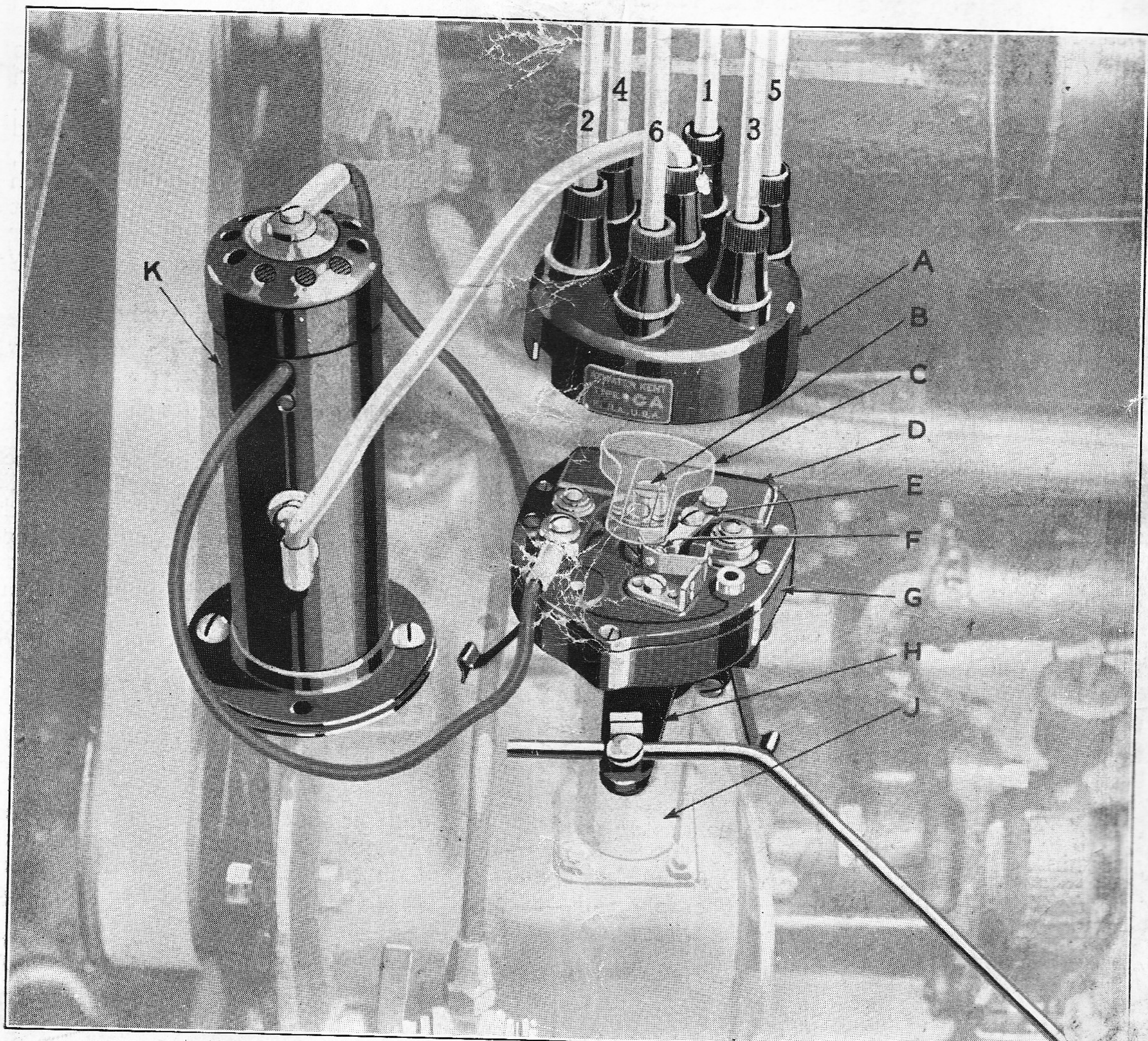


Figure No. 14

UNISPARKER AND COIL

A. DISTRIBUTOR
B. CAM
C. DISTRIBUTOR BLOCK
D. CONDENSER
E. ADJUSTABLE CONTACT HOLDER
F. CONTACT POINTS
G. BODY
H. ADVANCE LEVER
J. BRACKET
K. COIL

is so timed that the time of ignition can be advanced by means of the spark hand lever beyond the ordinary range of the automatic control to compensate for high speeds, or retarded for an idling speed when the car is standing.

Timing of Ignition

By its connection with the unisparker body, the spark control hand lever advances or retards the time at which the points in the contact maker are caused to open and produce a spark in the cylinders by tending to rotate the body and thereby rotate the contact arm around the six sided cam. This action is independent of the automatic advance feature which causes the cam to advance in the direction of its rotation. However, the limit of retardation, or the point from which the body is advanced, and the position of the cam with reference to the pistons and valves, must be established before the distributor shaft is coupled to its drive shaft, in order that the spark will occur in any cylinder within a certain limit before and after the piston has reached the peak of its compression stroke.

The unisparker will have been correctly timed before the car leaves the factory, and it is advisable not to change that setting unless for some reason it must be removed, in which case the work being performed will doubtless be under the supervision of a skilled mechanic. In any event the motor must be cranked until the piston in number six cylinder is at top dead center between the compression and firing strokes (as shown by the line on the flywheel rim, marked "DC" when it is opposite the pointer at the opening in the flywheel housing), after which the flywheel should be further rotated for a distance of 2″ on the 15″ diameter of the flywheel. It will be known that the piston is on its compression stroke by opening the relief cock over number six cylinder and holding a finger pressed tightly over the cup. The pressure of the gas can easily be noticed, and the opening in the flywheel housing should then be watched for the appearance of the line "DC." It will also be found by watching the opening and closing of the valves that as number one exhaust valve is just closing, number six piston is at the top of its compression stroke.

Having released the adjustable advance lever on the sleeve of the unisparker shaft (see Figure No. 14) the latter should be inserted into the bracket and revolved until its slotted lower end is engaged with the coupling on the upper end of the driving shaft; at the same time the fork on the adjustable advance lever should be caused to fall over the stop screw on the bracket. The unisparker body should next be rotated around the six sided cam until that point is reached where the contact points are just about to open; at that point the adjustable advance lever should be pushed toward the left, or "clockwise" until one side of the fork is resting against the stop screw. In other words, that lever should be placed in the fully retarded position and it should then be securely clamped to the sleeve of the unisparker shaft, care having been taken not to disturb the setting of the body. The set screw in the bracket should now be entered into the groove around the shaft sleeve, and the lock nut retightened.

Having completed the foregoing, the distributor block should be placed on the slotted upper end of the cam and the wire from the spark plug in number six cylinder should be connected to the terminal on the distributor whereat the block is pointed when the distributor is in its proper position on the body. Knowing that the distributor block rotates to the right or "clockwise," the wires from the remaining spark plugs should be connected in the firing order of 1, 5, 3, 6, 2, 4. In other words, having connected the wire from number six spark plug to the proper terminal on the distributor, the wire from number two cylinder would be connected to the terminal adjoining on the right. The wire from number four spark plug would be next in order, then number one, etc. The operation is completed by attaching the spark control rod to the adjustable advance lever and by connecting the wires from the coil to the distributor.

Maintenance

[illegible] contact points should be examined about once every month to see that they are closing [illegible] the space between them when they are separated is not less than eight thousandths [illegible] an inch or more than ten thousandths (.010) of an inch. When the points do not close [illegible]lly [illegible] should be removed and dressed with a piece of carborundum, or in its absence with a [illegible] file. When the contact points are removed, care should be taken not to disturb the [illegible] contact, as it is simply necessary to remove the screw which holds the contact arm [illegible] is by [illegible]

In case of missing, it should not be assumed that the difficulty is necessarily due to ignition, but should this prove to be the case, it should first be ascertained that the spark plugs are properly adjusted, clean and perfect in every particular. If the engine misses without regard to speed, each cylinder should be tested separately by disconnecting the plug wire and holding it within three sixteenths inch to one quarter inch from the plug terminal, thereby establishing a gap over which the spark must jump. If all plug wires show a regular spark, the difficulty is probably in the plugs. If any one cylinder fires regularly, this will indicate that the ignition system is in working order, so far as the distributor and coil are concerned, and it may be assumed that the trouble is probably in the high tension cables between the distributor and spark plugs or in the plugs themselves.

Should it be noticed in making a test that all plugs are sparking irregularly, the battery and connections therefrom should be examined. Where the difficulty commences suddenly, it is probably due to a loose connection in the wiring. However, it is possible that the battery may be weak or that the contact points require attention, in which case it would be well to have the battery tested and to see that the moving parts of the unisparker are not gummed with oil or rusted.

Spark Plugs

Economy of fuel and full power of the motor can only be obtained by giving proper attention to spark plug adjustment. The distance between the electrodes of the spark plugs must vary according to the individuality of the motor, but normally should not be less than 1/50th of an inch or not more than 1/32 of an inch. Difficulty in starting or missing at low speeds is often due to the spark plug gap being too wide and as the spark tends to burn the electrodes, thereby gradually increasing the gap, it becomes necessary to examine and readjust the electrodes occasionally. If the gap is extremely narrow there is a possibility of misfiring because the spark length may not be sufficient to properly ignite the charge.

Spark plugs should be kept clean and free from carbon, otherwise short circuiting may be caused. The points should be cleaned with fine emery cloth and washed with gasoline. The central electrode is insulated from the body of the plug with porcelain and should this porcelain become cracked, the plug should be replaced, as the current otherwise following the course of least resistance may jump the gap at the crack in the porcelain rather than through the highly compressed charge in the cylinder, thereby making the plug ineffective.

CARBURETOR

Explanation

A carburetor is a metering device, the function of which is mechanically to blend a liquid fuel with a certain amount of air to produce as nearly a homogeneous mixture as possible, and in such proportions as will result in as perfect an explosive mixture as can be obtained.

If a gas were used as a fuel, it would not be so difficult to obtain a homogeneous mixture, due to the intimacy with which a gas will mechanically mix with air. However, with a liquid fuel such as gasoline, it is quite different, especially with low test gasoline, and it is therefore the aim of all carburetor manufacturers to produce an instrument that will atomize the fuel and break it up into as small particles as possible, so that every minute particle of fuel will be surrounded by a correct proportion of air when it is discharged into the combustion chambers of the motor. To facilitate the vaporization of these minute particles of fuel, it has been found advisable to preheat the air taken into the carburetor, thereby furnishing the necessary heat units.

Operation

The accompanying illustration (Figure No. 15), is a sectional view of the Rayfield ca[illegible] and indicates by arrows the travel of the gas through the instrument. Gasoline enters the ca[illegible] through the gas line (A) passing through the strainer (B) needle (D) and into the float chamber [illegible] The float (E) raises with the inflow of gas, which automatically raises the two fu[illegible]mly causes needle (G) to seat when the proper level is reached, thereby stopping the flo[illegible] the motor suction again exhausts the gas from the float chamber. Fuel is s[illegible]

two sources—(M) supplies all the gasoline required when the motor is idling and at low speed; the additional gasoline required for higher speeds is furnished through a tube (N) which is controlled by a tapered metering pin located under the automatic air valve.

This carburetor has three air intakes: The constant or fixed opening (J), and two automatically controlled air valves (K and L). The automatic air valves are inter-connected and operate together to increase the supply of air proportionately to the additional gas supply caused by the increased suction of the motor. A piston attached to the upper automatic air valve operates in a cylinder of gasoline. When the carburetor is in operation, the resistance offered this piston by the gasoline serves to create a strong suction on both sources when the throttle is opened suddenly and by its pump effect forces gasoline through the metering pin tube.

Dash Control

The carburetor is equipped with a dash control which raises the low speed adjusting needle, supplying a richer mixture for starting the motor when stiff or cold. When pulled all the way out,

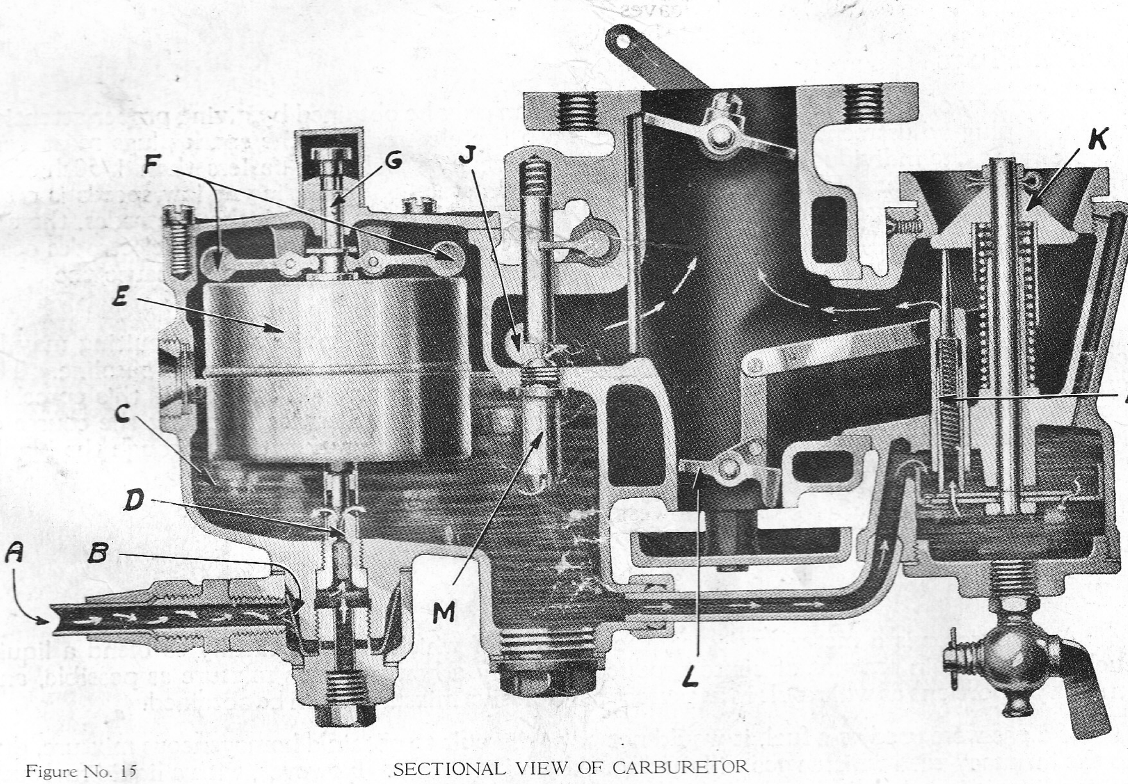


Figure No. 15 SECTIONAL VIEW OF CARBURETOR

it not only raises the low speed needle, allowing for a richer mixture of gas, but also operates the starting primer. This primer provides an increased charge of gas from the float chamber directly into the motor. It is controlled by a plunger valve with two by-pass openings—one in the throat of the carburetor above the throttle butterfly; the other in the float chamber beneath the gas level. By pulling out the dash control full length, which automatically pushes the plunger valve down, the by-pass is opened and the motor draws a very rich charge of gas directly from the float chamber. The throttle must be closed in order to obtain this action effectively.

Heat to Carburetor

[illegible] mentioned that heat must be supplied to the carburetor to properly vaporize [illegible] fuel now in use. Warm air is drawn into that instrument through a flexible [illegible]ing it [illegible] a "stove" clamped around the exhaust pipe, and a water jacket on the carburetor [illegible] for the circulation of hot water around the mixing chamber. The water is drawn [illegible] by [illegible]

from the cylinder head through a copper tube and has outlet through another tube which passes around the front of the motor and is connected to the water pump intake.

The circulation of water around the carburetor can be stopped if desired by closing the valve at top of the inlet tube. The jacket can be drained through the cock at bottom where the tube is attached to the carburetor. **It is Very Important that all Water is Drained from the Carburetor when the Motor is Allowed to Remain Idle During Cold Weather. If this is Neglected, the Water will Freeze and the Jacketing will be Cracked by the Internal Pressure.**

Adjustment

This carburetor has no air valve adjustment and only two gasoline adjustments. Both of these are turned to the right for a richer mixture, as indicated on the adjustment screw heads. The low speed adjustment must be completed before adjusting for high speeds.

When adjusting for low speeds the throttle should be closed, and with the dash control down, the nozzle needle should be closed by turning the low speed adjustment (A) Figure No. 16, to the left until the block (D) slightly leaves contact with the cam (C). It should then be turned to the right about three complete turns. The throttle control hand lever should now be advanced about one inch on the sector, the motor started and allowed to run until it is warm. If the spark hand lever has been advanced it should now be fully retarded and the throttle should be closed until the motor runs slowly without stopping. The final low speed adjustment may be made by turning the low speed screw to the left until the motor slows down. It should then be turned to the right a notch at a time until the motor idles smoothly. If the motor does not throttle low enough the screw in the stop arm, on the lever end of the throttle valve stem, should be turned to the left until the motor runs at the lowest number of revolutions desired.

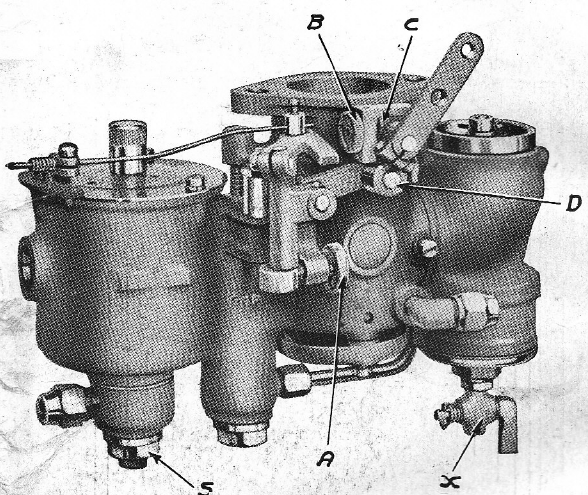


Figure No. 16

EXTERNAL VIEW OF CARBURETOR
(Illustrating Points of Adjustment)

To adjust for high speeds the spark control hand lever should be advanced about one-third its travel distance on the sector, and the throttle should be opened rather quickly. Should the motor back-fire, it indicates a lean mixture which may be corrected by turning the high speed adjusting screw (B) to the right about one notch at a time until the throttle can be opened quickly without causing the motor to back-fire. If "loading" (choking) is experienced when running under heavy load with throttle wide open, as in climbing a steep grade, it indicates too rich a mixture. This can be overcome by turning the high speed screw to the left.

The dash control when properly used will render easy starting, furnish a richer mixture when the motor is cold, and maintain a correct mixture under the most extreme atmospheric changes. When carburetor adjustments are once made, they should not be changed, as the dash control will provide for all cold weather conditions.

Care

The float chamber and dash pot should be drained occasionally through the drain cock (X) to remove water and sediment which may have accumulated. All carburetors are equipped with a strainer trap at the bottom of the float chamber. To clean this trap the gasoline supply should be shut off and the nut (S) removed. The gauze may then be re[illegible] and cleaned. In replacing the trap it should be seen that the gaskets are in place [illegible] the [illegible] firmly tightened to insure a tight joint. The trap can be drained by shut[illegible] the [illegible] and removing the small plug at bottom.

FUEL SUPPLY SYSTEM

Explanation

As the gasoline supply tank is mounted at the rear end of the frame on a level below the carburetor intake, it is necessary to provide a means of supplying fuel to that instrument other than by gravity. This is accomplished by the Stewart Vacuum System which employs a small tank attached to the dash under the hood. This tank is connected by brass tubing to the intake manifold, also to the gasoline supply tank and to the carburetor. The motor draws its supply of gasoline through the carburetor by reason of the pumping action of the pistons. It is this same pumping action which draws gasoline from the main supply tank into the vacuum tank through the connection of the manifold and the vacuum tank, and also the connection of vacuum tank with the main supply tank.

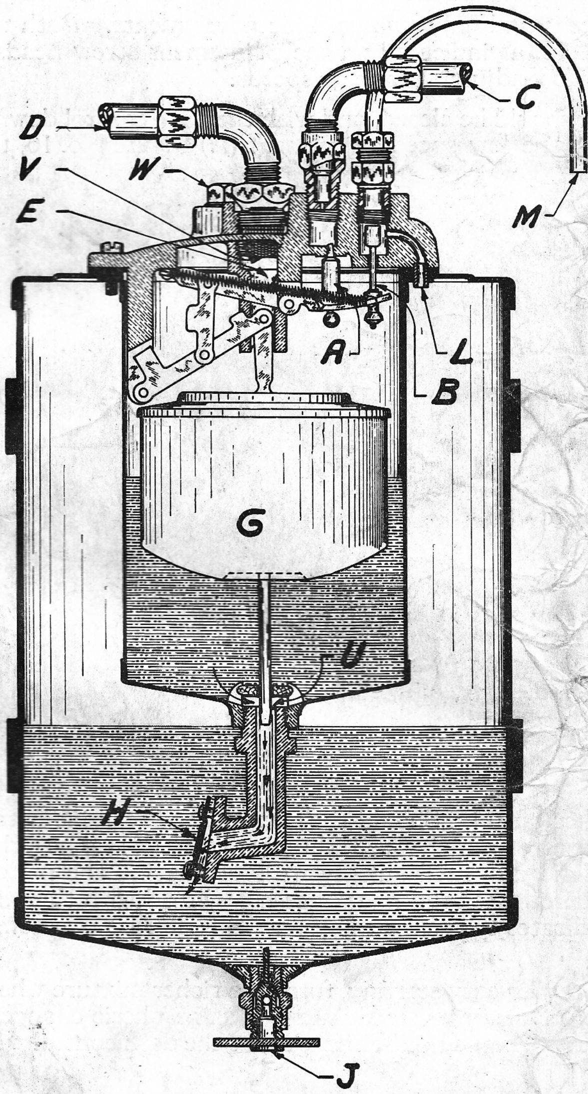


Fig. No. 17 STEWART VACUUM TANK

Operation

The vacuum tank consists of two chambers, the upper or filling chamber and the lower or emptying chamber. Between these chambers is a partition in which is placed a valve. The suction of the pistons on the intake stroke creates a vacuum in the upper chamber. This vacuum closes the valve between the two chambers and also draws or pumps gasoline from the main supply tank into this upper chamber. As the gasoline flows into the upper chamber it raises a float which operates a valve when it has reached a certain point, thereby shutting off the suction and opening an air valve.

This admission of outside air releases the vacuum suction, thus causing the valve leading into the lower chamber to open and allowing the gasoline to flow into the lower or emptying chamber. The lower chamber is always open to the outside air so that nothing can prevent the gasoline from feeding to the carburetor in an even uninterrupted flow. The main supply tank has a capacity of $21\frac{3}{4}$ gallons.

Care and Repair

The simple, durable construction of the vacuum tank makes it unlikely that the car owner will need to make internal repairs. If the motor fails to start, it is not necessarily due to improper action of this system. If the carburetor can be flooded by lifting the needle valve under the cap at top of the float chamber, it will be known that the system is performing its work, and that the difficulty is due to such causes as an improperly adjusted carburetor, faulty ignition, etc.

If it has been proved that the vacuum system is at fault it may be that the float (G) Figure [illegible]o. 17, which [illegible] be air tight, has developed a leak; thus allowing it to become filled with gasol[illegible]e [illegible] heavy to rise and close the vacuum valve. This causes the motor to "l[illegible] [illegible] the same manner as would result from too rich a mixt[illegible] in the car-

m[illegible]

is[illegible]

In removing the top of the tank after taking out the screws, a knife blade should be inserted between the cover and body so as to separate the gasket without damage. The gasket is shellacked to make an air tight joint. Having removed the top to which the float is attached, the latter should be dipped into a pan of hot water. Bubbles will be seen at the point where a leak occurs and in such case the spot should be marked. Two small holes should then be punched in the float, one in its top and the other in the bottom, in order that it may be emptied of the gasoline. The holes should then be soldered and the float again tested. In soldering the float care should be taken not to use more solder than required. Any unnecessary amount will add to its weight and interfere with proper action. In removing the float and while repairing it, care should be taken not to bend the float guide rod. If bent it will strike the guide and retard the float action, thereby producing the same effect as a leaky float. It should also be seen that the surface of the rod is perfectly smooth for the same reason.

To temporarily overcome the condition of a leaky float until it can be repaired, the tank should be allowed to fill by running the motor. The plug (W) should then be removed and the car driven until the supply of gasoline is nearly exhausted. The plug can be replaced and the tank again allowed to fill. This procedure can be repeated until a repair station has been reached.

Another condition which might cause difficulty is that a small particle of dirt or other foreign matter may become lodged under the flapper valve (H) in a manner to prevent the valve from closing. To prove such a condition the air vent (M) must be plugged and the tube to carburetor disconnected at the tank. The motor should then be started and the finger applied to the opening. If there is a continuous suction it is evident that the valve is not closing or that there is an air leak in the tubing from the main supply tank or its connections.

In many cases this condition of the flapper valve can be remedied by merely tapping on the side of the tank, thus shaking loose the particle of dirt which has clogged the valve. If this is not effective the top should be removed and the inner tank lifted out.

The gasoline strainer (V) collects all foreign substances that might find their way into the gasoline. If the tank fails to work it may be that this screen is clogged. This should be the first point to be investigated in case of failure and the screen should be cleaned about every three or four weeks in any event. It is simply necessary to unfasten the connection into which the elbow is screwed.

The air vent (M) allows an atmospheric condition to be maintained in the lower chamber and also serves to prevent an overflow of gasoline in descending steep grades. If once in a long while a small amount of gasoline escapes, no harm will be done and no adjustment is needed. However, if the vent tube regularly overflows it may be caused by the air vent hole in the filler cap on the main supply tank having become closed. This difficulty can be overcome by opening the vent.

ELECTRIC STARTING AND CHARGING SYSTEM

Generator

The work of a generator is that of converting the mechanical energy imparted to it by the engine, into electrical energy which is used directly for lighting and ignition or accumulated in the battery for later use in starting the engine or for lighting and ignition when the generator is at rest or when it is operating too slowly to generate current.

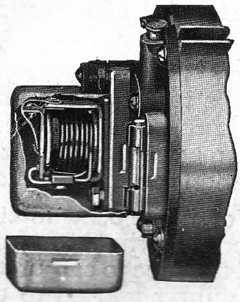
An armature, which briefly consists of a number of loops of wire mounted in a rigid manner on a laminated iron core, is caused to revolve at a high rate of speed in a magnetic field produced by Electro-Magnets. The electro-magnets are simply bars of iron attached to the body of the generator, which are wound with coils of wire and caused to become magnetized by the current passed through them. The magnetic influence which passes between the Poles or ends of the electro-magnets—which are known as the Fields—are called "lines of force." These lines of force flow out of a North Pole so-called, around to the South Pole and through the core back [illegible] the North Pole. The space between these magnets, occupied by the lines of force, is called t[illegible] Magnetic Field.

It has been shown that if an electric current is passed through [illegible]onductor such as th[illegible] generator Fields, a magnetic field is produced between the poles of [illegible]ductor[illegible] If another

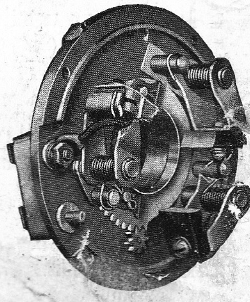
conductor such as the armature is passed or revolved between the poles of the Fields, through the magnetic field so that the lines of force of the field are cut by it, an electric pressure is generated in the Armature which will cause a flow of current.

Direction of Current Flow

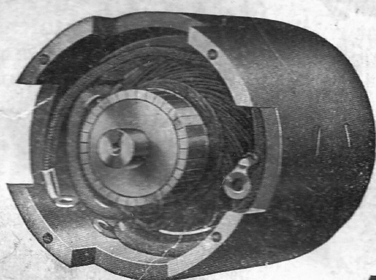
The ends of each loop of wire which compose the armature are connected to bars forming the Commutator, and by placing carbon brushes in contact with this Commutator the current is collected and directed through the external circuit. The current thus collected is passed from the Positive Brush of the generator into the metal frame of the car. Being also connected to the frame, the Storage Battery accumulates the current through its positive Terminal and passes it through the Negative Terminal into a wire connected with the positive side of the Ammeter, which indicates the rate of flow. From the negative side of the ammeter the current is passed to the Relay or Automatic Cut-Out, thence to the Negative Brush on the commutator of the generator, thus completing the charging circuit.



Cut-out and Fuse accessibly mounted



Simplicity of Third B A tment



Construction readily permits inspection of interior

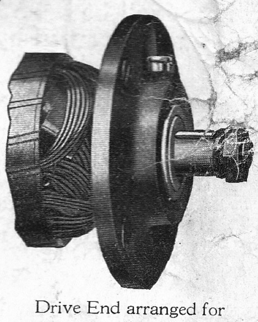


Figure No. 19

Drive End arranged for convenient disassembly

GRAY & DAVIS GENERATOR

One side of the electric bulbs in each of the headlamps and the bulbs in the side and rear lamps, as well as those in any additional lamps, is grounded to the frame. The other side is connected through the switch to the negative side of the ammeter. When the generator is charging with the lamps burning, the current flows from its positive brush through the frame to the lamps and returns to its negative brush through the switch, ammeter and relay, thus completing the lighting circuit. Any current which is generated in excess of that required for lighting and ignition is passed through the charging circuit. At low speeds when little or no current is being delivered by the generator the current flows from the positive side of the battery through the frame to the lamps and ignition system and returns to the negative terminal of the battery through the switch and ammeter.

Regulation of Generator Output

The necessity for some form of automatic regulation to control the output of the generator is quite apparent. It will be seen that fundamentally the current produced by a generator increases with the speed, and since the speed of the engine from which the generator is driven varies between wide limits, the current value would also fluctuate unless properly controlled. If the charging rate is too high, the generator is overheated and the battery may become overcharged.

There have been numerous forms of generator regulation, but one of the most simple and successful has been the so-called Third Brush. This type takes its name from the fact that an additional or Third-Brush placed on the generator commutator is connected to the field windings. These windings instead of being connected across the two main brushes, as in the ordinary Shunt-Wound type, are connected from the positive brush to the third brush. The generator starts to charge at low driving speed and delivers its full charging current at average driving speed. Above

LAMP BULB DATA						
USED	PAIGE NO.	CONTACT	CANDLE POWER	BULB DIA.	MAZDA NO.	BULB NO.
HEAD LAMPS	6739	SINGLE	15	1 3/8"	1125	S11
HD LAMP DIMMERS	6423	SINGLE	4	1"	81	G8
SIDE & TAIL	3245	SINGLE	2	3/4"	63	G6
TONNEAU LAMP	3241	DOUBLE	4	1"	82	G8
DASH LAMP	3242	DOUBLE	2	3/4"	64	G6

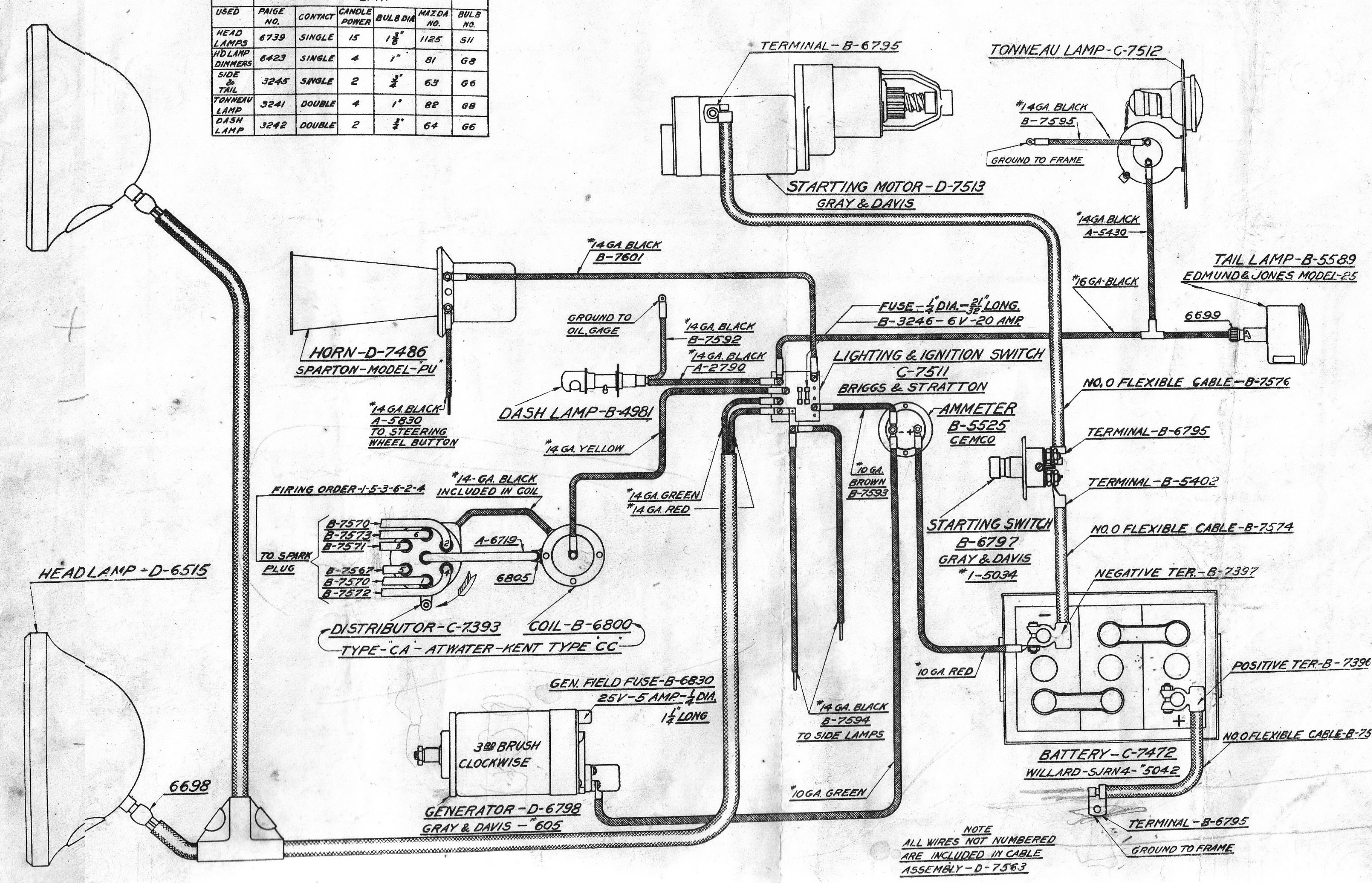


Figure No. 18

Diagram of Wiring System with Gray & Davis Generator and Starting Motor

LAMP BULB DATA

USED	PAIGE Nº.	CONTACT	CANDLE POWER	BULB DIA.	MAZDA Nº.	BULB Nº.
HEAD LAMPS	6739	SINGLE	15	$1\frac{3}{8}''$	1125	511
HD. LAMP DIMMERS	6423	SINGLE	4	1"	81	G-8
SIDE & TAIL	3245	SINGLE	2	$\frac{3}{4}''$	63	G-6
TONNEAU LAMP	3241	DOUBLE	4	1"	82	G-8
DASH LAMP	3242	DOUBLE	2	$\frac{3}{4}''$	64	G6

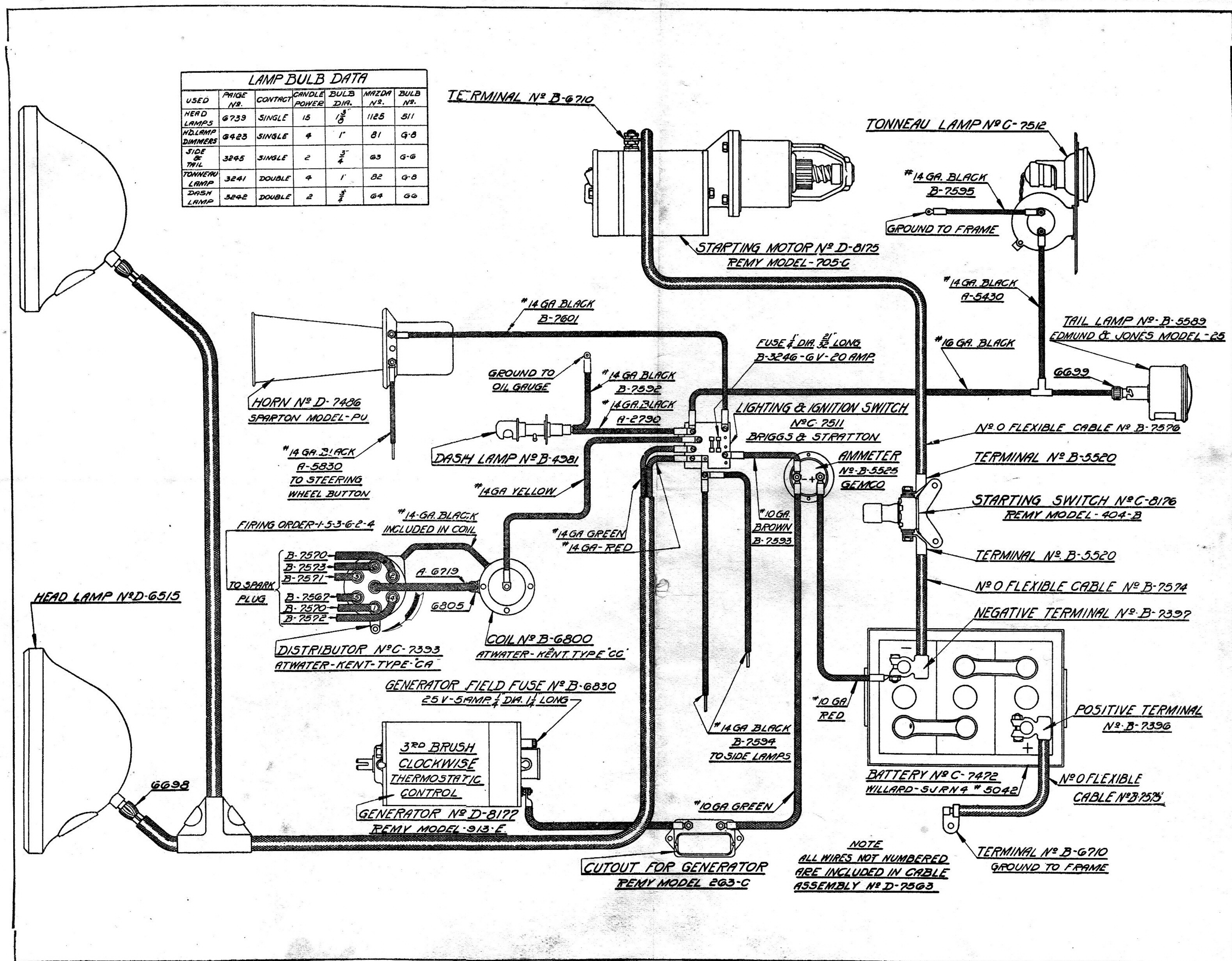


Diagram of Wiring System with Remy Generator and Starting Motor

the average speed the third brush, due to inherent characteristics produced within the generator, reduces the current automatically so that the battery is not subjected to an excessive charge. This action may be described as follows:

When the armature is turning at a certain definite speed there is a certain difference of potential between the third brush and the positive brush. This difference of potential or voltage produces the current in the shunt fields. As the armature increases in speed, there will be an increase in the distortion of the magnetic field, or in other words an increase in the armature reaction. This will lower the voltage between the third brush and the positive brush and will consequently diminish the current in the shunt fields. This reduction in shunt field current lowers the charging rate.

Relay or Automatic Cut-out

The Relay or Automatic Cut-out (mounted at the rear end of the Gray & Davis generator, with which the model 6-66 cars were originally equipped, and on the dash since Remy equipment was adopted) is simply an automatic switch for connecting and disconnecting the battery charging circuit. If the battery was not disconnected from the generator when the engine stops or when the car is driven too slowly for the generator to charge, reverse current would flow from the battery back through the generator windings and would soon exhaust the battery. This instrument is, therefore, provided to act as a check valve, permitting the charging current to flow to the battery when the generator is driven fast enough to produce current and causing the circuit to open when the engine slows down or stops, thereby preventing flow of the current in the opposite direction.

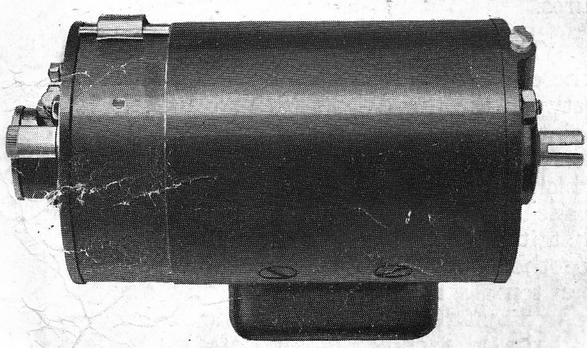


Figure No. 20 REMY GENERATOR

The Relay is composed of a soft iron core on which two coils of wire are wound. There are also two contact points, one of which is stationary and the other attached to a movable arm with a spring hinge. The inner coil of fine wire, known as the Shunt coil, is directly connected across the positive and negative brushes in the generator. The spring on the movable arm holds the contact points apart when the generator is at rest, but when it is driven at sufficient speed to develop voltage equal to the battery voltage, the shunt coil is energized and the magnetism thereby produced pulls down the arm, thus closing the contact points and connecting the Series coil with the battery. The Series coil is simply a few turns of heavy wire over the shunt coil but insulated from it—through which the main current to the battery and all points in the wiring system is carried. The charging current passing through the series coil after the contact points have closed further increases the magnetism and insures that the arm will be held down to a firm contact. As soon as the generator slows down or stops it no longer energizes the shunt coil. The arm would tend to stay down, however, due to slight "Residual" magetism were it not for the action of the series coil. When current starts to flow from the battery in a reverse direction back through the generator, it passes through the series coil so that the magnet is demagnetized and the contact points released.

If the relay points become dirty or show uneven wear, they may be cleaned and leveled by passing between them a piece of number 00 sandpaper. Care should be taken not to spring the arm or to change either the opening between contacts or the spring tension. The spring tension is correctly set to operate at the proper time for connecting and disconnecting the points and must not be changed.

Remy Thermostat Control

The battery is called upon for considerably more current during the winter months than during other seasons of the year because of the increased use of lights and longer application through starting motor required to start a cold engine. Furthermore, since the condition of the brush.

during cold weather imposes slower driving, the battery does not receive even the normal amount of recharge. With the Gray & Davis type of generator this difference in operating conditions is provided for by an adjustment of the Third-Brush to increase the current output during the winter months over that required during warm weather. In the Remy generator, however, we have an instrument of larger capacity and the current output is reduced automatically by a patented feature, when such reduction is necessary.

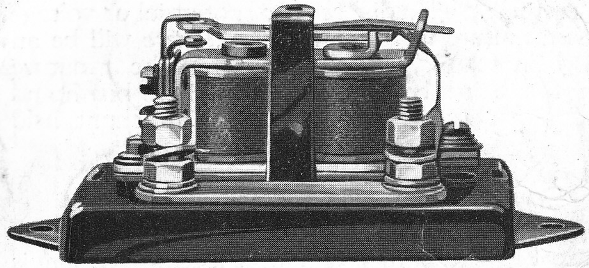


Figure No. 21 RELAY—REMY GENERATOR

A larger capacity generator could not safely be used without some means of protecting the battery from the overheating which a continuous high charge rate would cause, especially during warm weather. Overheating will seriously damage the plates and materially shorten the life of a battery. The Remy patented Thermostat Control has made it possible to furnish a generator of large current capacity for cold weather usage by reducing the charging current automatically whenever the generator tends to heat up. The generator will naturally heat up more quickly during the warm seasons than during the winter months; therefore, the battery as well as the generator is protected. The thermostat thus insures not only maximum battery life, but enables the highest charging rate to be used which the battery may safely receive at the different temperatures.

The thermostat is mounted in an accessible place at the commutator end of the generator—where it is protected from any mechanical injury—and is inserted into the generator field circuit between the third and positive brushes. It is composed of a resistance unit, two silver contact points—one of which is rigidly mounted—and a spring blade which holds the other contact point. The blade is made of a strip of spring brass welded to a strip of nickle steel—a combination which warps at its free end when heated, due to the greater expansion on the brass side. The blade is riveted through insulation washers to the bracket, and the spring tension is fixed so that it holds the two contact points firmly together at low temperatures. As soon as the temperature of the generator rises to approximately 175 degrees F. the blade bends and the contact points separate. When the contacts are closed, full field current passes through them and permits full current output from the generator. After the rise in temperature of the generator the automatic Thermostat inserts the resistance into the field circuit and thus reduces the output.

The maximum charging current from the Remy generator is 18-20 amperes from a cold start and this is reduced by the thermostat control to between 9 and 12 amperes after a period of running, depending entirely upon the speed, the condition of the battery and the atmospheric temperature. The reduction may therefore occur within a few minutes or not at all if the weather is cold or the stops are frequent. It will always occur before the generator reaches an excessive temperature.

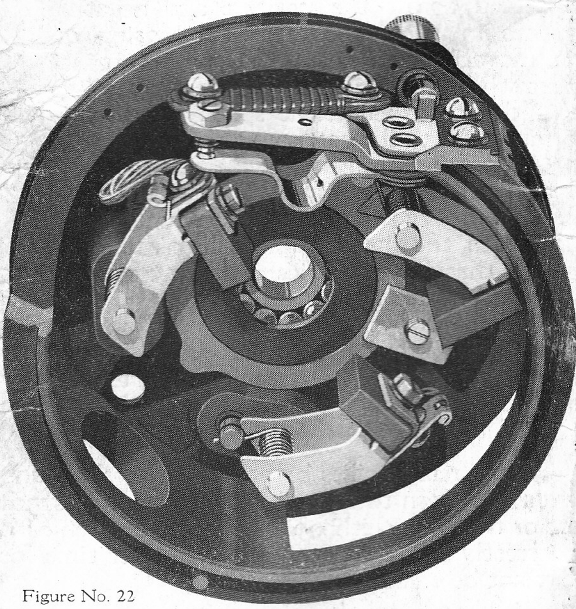


Figure No. 22

THERMOSTAT AND BRUSH RIGGING
(Remy Generator)

Generator Protection

A Fuse is located at the rear end of both the Gray & Davis and Remy generators and its ... is limited for the protection of the Field windings in the event of a break in the charging ... Usually its failure is direct evidence of either a loose wiring connection—particularly at ...ery—or sulphated battery terminals which have caused high resistance in the charging

circuit. This condition produces high voltage at the generator, which would damage the Field windings were they not protected by the failure of the Fuse and opening of the Field circuit. The generator should never be run unless it is connected to the battery. In the absence of a battery the Fuse should be removed to protect the windings.

This fuse should never be replaced with a wire or a fuse of greater capacity than the standard 25 volt, 5 ampere fuse, otherwise the generator will be subjected to serious damage in the event of an open circuit.

Third Brush Adjustment

When the Gray & Davis generator is tested before being installed, it is run at various speeds from 500 to 3000 revolutions per minute and the third brush is adjusted so that the charging rate at any speed will not exceed a definite amount, usually 12 to 15 amperes. Owing to the action of the third brush at speeds higher than that at which the generator gives 12 to 15 amperes, the charging rate tapers off to about 10 amperes.

The position of the third brush should never be changed unless it is certain that the battery receives more or less current from day to day than is desirable, and while the output can be changed if necessary by simply turning the pinion screw, located at the bottom of the rear cover plate between the fuse and the cutout, it is recommended that the instrument be taken to the Service Department of a Paige Distributor or Dealer for adjustment, to avoid possibility of damage which would result if the third brush was adjusted to give an excessive rate of charge. A very slight turn of the screw will materially affect the charging rate.

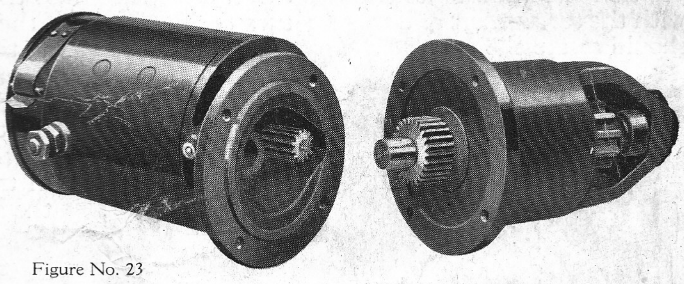


Figure No. 23
REMY STARTING MOTOR AND DRIVE ASSEMBLY

Should it be considered necessary to reduce the current output of the Remy generator, it will be advisable to have this adjustment made by a branch or Service Station of the United Motors Service, Inc., who have the contract of servicing all Remy equipment. The necessary adjustment should be made only after the generator has cooled down to atmospheric temperature and the third brush should then be moved only slightly. Where a reduction in the current output is necessary, a reduction of one to two amperes in the maximum charging rate will in all probability be sufficient. Unless most of the driving during summer months is made up of unusually long day light trips with little or no use of the lamps, the thermostat will be found to control the current output without any attention to the third brush adjustment.

Where the charging rate does not exceed 15 amperes when the generator is thoroughly cooled, it should be determined if the ammeter indicates a correct zero with the engine at rest and with all lights and the ignition turned off. If low current persists before the reduction in the charging rate occurs by thermostatic action, it would be advisable to investigate the condition of the commutator and brushes. A removable dust tight cover around the end of the generator permits easy access to these parts. The commutator will naturally show a brown color in normal use, but should it appear black or scored its surface should be smoothed with a piece of number 00 sandpaper. **Emery cloth should never be used for this purpose.** It should also be seen that the brushes swing freely on their pivots and that they are held in proper contact with the commutator by the spring tension. If the charging rate is not improved after having cleaned the commutator and made an inspection of the brushes, it may be necessary to have the third brush adjusted to increase the current output.

Starting Motor

It has been explained that the work of the generator is that of converting mechanical into electrical energy, but with the starting motor conditions are reversed, as it depends upon the storage battery for its energy. The starting motor has practically the same parts and construction as the generator but the current is received into the loops of wire composing the armature through the negative brush and commutator and passed through the field coils to the positive brush.

From the latter point the current is returned to the negative terminal of the battery through a heavy cable and starting switch.

It is known that if an electric current is allowed to flow through one or a number of loops of wire a magnetic field is produced which circles the wire and lasts as long as the current lasts. If these loops of wire—which compose the armature—are placed in a parallel magnetic field, the whirling field about the loops together with the parallel field, produces a force tending to move the loops of wire. This is the principle of the electric motor.

The starting motor is provided with the Bendix Drive which engages it with the engine automatically. The extended shaft of the starting motor carries a hardened steel sleeve upon which is cut a screw thread. Operating upon this sleeve is a steel pinion having a lateral travel of about one and one-half inches for engaging the gear teeth on the flywheel. A helical steel spring serves as a flexible coupling between the starting motor and the engine. It also facilitates engagement of the gears.

Sequence of Operation

When the starting motor is supplied with current, its armature being free, starts to revolve at a high rate of speed. Normally the pinion is in a demeshed position, and being weighted on one side tends to lag behind the rotation of the shaft by reason of its inertia. This causes it to move endwise and it is thus drawn into mesh with the gear on flywheel. If the pinion is in a meshing position it continues its endwise travel until it reaches the stop collar, which causes it to rotate with the screw-shaft and thereby turn the flywheel. If the pinion teeth instead of sliding between should strike the ends of the flywheel teeth, the spring through which the screw-shaft is driven permits the pinion to mesh with the next tooth without shock or binding. As soon as the engine starts firing, its increased speed of rotation threads the pinion back in the opposite direction, thus disengaging the starting motor from the engine.

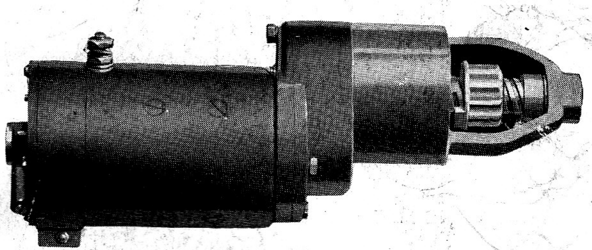


Figure No. 24
GRAY & DAVIS STARTING MOTOR

Retard Spark When Starting

Before starting appliances came into common usage when operators of automotive vehicles were accustomed to cranking the engine by hand, they were aware of the personal danger in attempting to start with an advanced spark lever and were careful to take the necessary precaution to prevent possibility of a back-fire. However, since the inception of the electric starting motor, the fear of injury has been removed with the result that attention to retardation of the spark is often neglected.

A back-fire is the result of a premature expansion of gases in the engine cylinder when starting, reversing the direction of rotation of the crankshaft against that of the starting motor armature, which is exerting its full power in the opposite direction, thus bringing two main forces together. Under such conditions the tooth of the flywheel gear at point of contact with the Bendix pinion may be unable to withstand the shock with the result that the teeth of the gear will be broken. Failing in this there will be a tendency to spring the armature shaft on which the Bendix Drive sleeve and pinion are mounted and to distort the coil spring through which the drive is accomplished.

Maintenance

The commutator and brushes of the starting motor are designed to carry a heavy current without injury, and under normal conditions will require little attention during the life of the car. Normally, the commutator should be cleaned about once a year with 00 sandpaper as in the case of the generator. A removable cover makes the commutator and brushes easily accessible. Should the commutator surface become rough and pitted, making the motor inoperative, it will be advisable to have necessary repairs performed by a Branch or Service Station of the United Motors Service, Inc.

Attention is called to the fact that there is a drain hole in the band covering the commutator

and brushes of both generator and starting motor. If it is removed, care should be taken to have this hole at the bottom when the band is replaced.

Storage Battery

The Willard 6 volt storage battery, which is located under the driver's seat, is an electro-chemical apparatus, and acts as the reservoir into which the electrical energy, supplied by the generator is stored for purposes of starting, lighting and ignition.

It is a common impression that a storage battery receives and stores up the actual electricity used in charging it. On the contrary the charging to the battery causes certain electro-chemical action between positive and negative plates in the presence of a medium known as electrolyte or battery solution. This does not actually store up electricity, but produces a chemical change in the plates. When a circuit is established between the elements the active material of the plates changes back to its original condition and an electrical current is generated.

Construction

The "grid" or frame work of a plate is cast from an alloy consisting chiefly of lead and is similar in appearance to filigree work. The open spaces are filled with a paste or compound consisting chiefly of lead. The positive plates when properly formed and finished, are composed of peroxide of lead which is of a dark brown color, and the negative plates are of porous, spongy lead, which is gray in color. A number of plates of the same kind connected together is called a "group." An "element" is formed by placing a positive and negative group together so that the plates alternate and are prevented from touching each other by separators. When this element is placed in a jar containing a mixture of sulphuric acid and water (electrolyte), it is called a cell. A battery is composed of one or more cells, the number depending upon the voltage required. A six volt battery is composed of three cells.

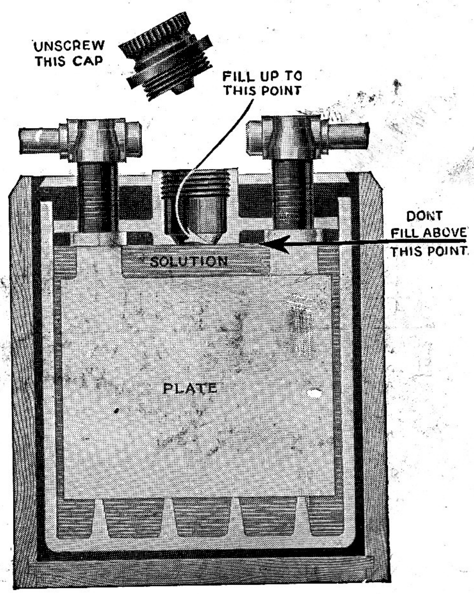


Figure No. 25 STORAGE BATTERY (Sectional View)

The chemical process previously referred to as taking place in the plates while charging, is reversed in the discharge—the plates reabsorbing from the solution the acid which was excluded during the charging, thus forming a lead sulphate which is again converted into its original form in the plates when the battery is re-charged and the cycle is completed.

Maintenance

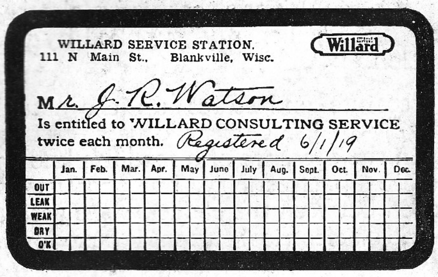
When a new car is purchased, the owner should visit the nearest Willard Service Station immediately in order that the battery in his car may be registered, and that he may receive the advantage of the Willard 90-day insurance policy. At that time he should ask for a service card on which the registration date will be written as shown in Figure No. 26. When a Williard battery is purchased to replace the original it will be registered when sold.

The owner should make a practice of testing the battery on the first and fifteenth of every month with a "Hydrometer" purchased from a Willard Service Station on his first visit. Fully charged cells should read between 1280 and 1300. If any cells are below 1275 on two successive testing dates the battery should be taken to a Service Station and fully charged. In taking these readings, care should be exercised to return the electrolyte from the hydrometer syringe to the same battery cell from which it was taken. **All cells should be kept filled with distilled water to a level one half inch above the top of the plates. They should never be filled above that level.**

The battery and its compartment should be kept clean and dry. The terminals should also be clean, tight, and well covered with vaseline to prevent corrosion. Th... ery should

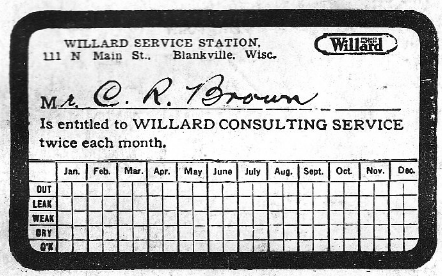
never be allowed to become heated in service above 100 degrees F., especially in warm weather, and if it is found that the top connectors are more than blood warm to the touch the temperature of the battery should be taken with a dairy thermometer. Should the temperature register over 100 degrees F., all lamps should be burned while driving until a Willard Service Station can be consulted. Should the temperature reach 120 degrees F., the battery will be ruined. During cold weather the battery should be tested frequently and the specific gravity should never be allowed to fall below 1275. A discharged battery will freeze a little below freezing point.

In the event that the car is stored for the winter, the battery should be removed and placed in storage with a battery service station. It is to be remembered that a battery will slowly discharge when standing. Serious damage will result if it is not kept charged, and it has been found impractical to charge by running the motor when the car is not in use.


WILLARD SERVICE STATION.
111 N Main St., Blankville, Wisc.
Willard
Mr. J. R. Watson
Is entitled to WILLARD CONSULTING SERVICE twice each month. Registered 6/1/19

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
OUT												
LEAK												
WEAK												
DRY												
O'K												

Figure No. 26
REGISTRATION SERVICE CARD


WILLARD SERVICE STATION.
111 N Main St., Blankville, Wisc.
Willard
Mr. C. R. Brown
Is entitled to WILLARD CONSULTING SERVICE twice each month.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
OUT												
LEAK												
WEAK												
DRY												
O'K												

Figure No. 27
CONSULTING SERVICE CARD

CLUTCH

Explanation

There are two main connections between the motor and rear axle, namely the clutch and the transmission, either of which can be disengaged at the will of the operator. The power of a motor is limited primarily by its size but within a certain range its power is largely dependent upon the speed at which it is operated and its ratio to the rear axle. When it is found desirable to exert power in excess of that procurable from the motor at a certain speed it becomes necessary to increase its ratio to the rear axle by changing the relation to each other of reduction gears contained in a housing attached to

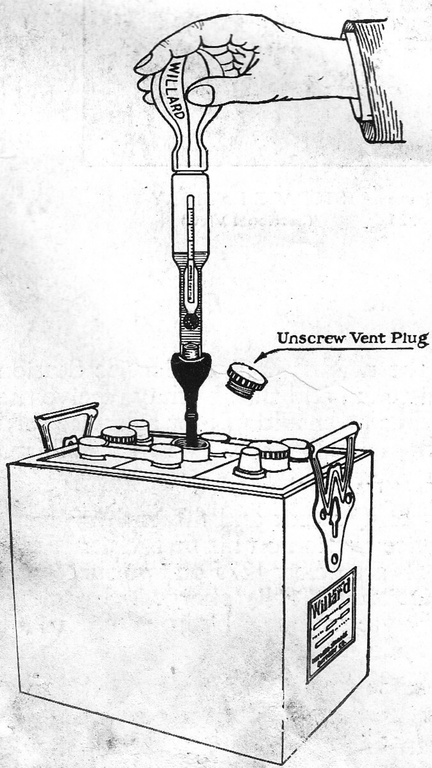
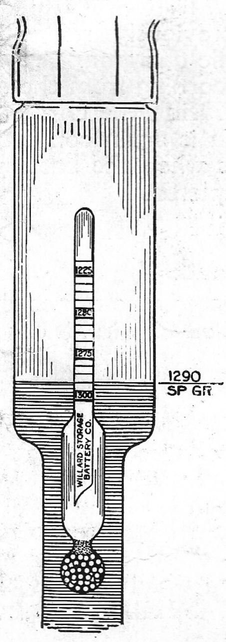


Figure No.



Reading for fully charged battery should be between 1280 & 1300
Figure No. 29

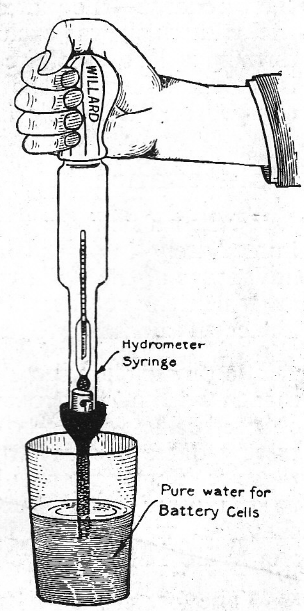


Figure No. 30

the rear end of the motor and known as a "transmission." In order that this change may be accomplished while the motor is running it is necessary to break the connection between the motor and transmission momentarily. This connection must be so constructed that it will release the one from the other and re-engage them quickly and smoothly; at the same time there can be no loss of power transmission as a result of slippage when a positive connection is required. This work is performed by the "clutch," and because it has the function of transmitting the power of the motor and at the same time of cushioning that power in picking up the load, its influence on the life of the transmission and drive units is all important.

Operation

The clutch is contained within the flywheel which has been formed into a hollow drum by the attachment of a cover. The rear end of the crankshaft is bored to support a roller bearing in

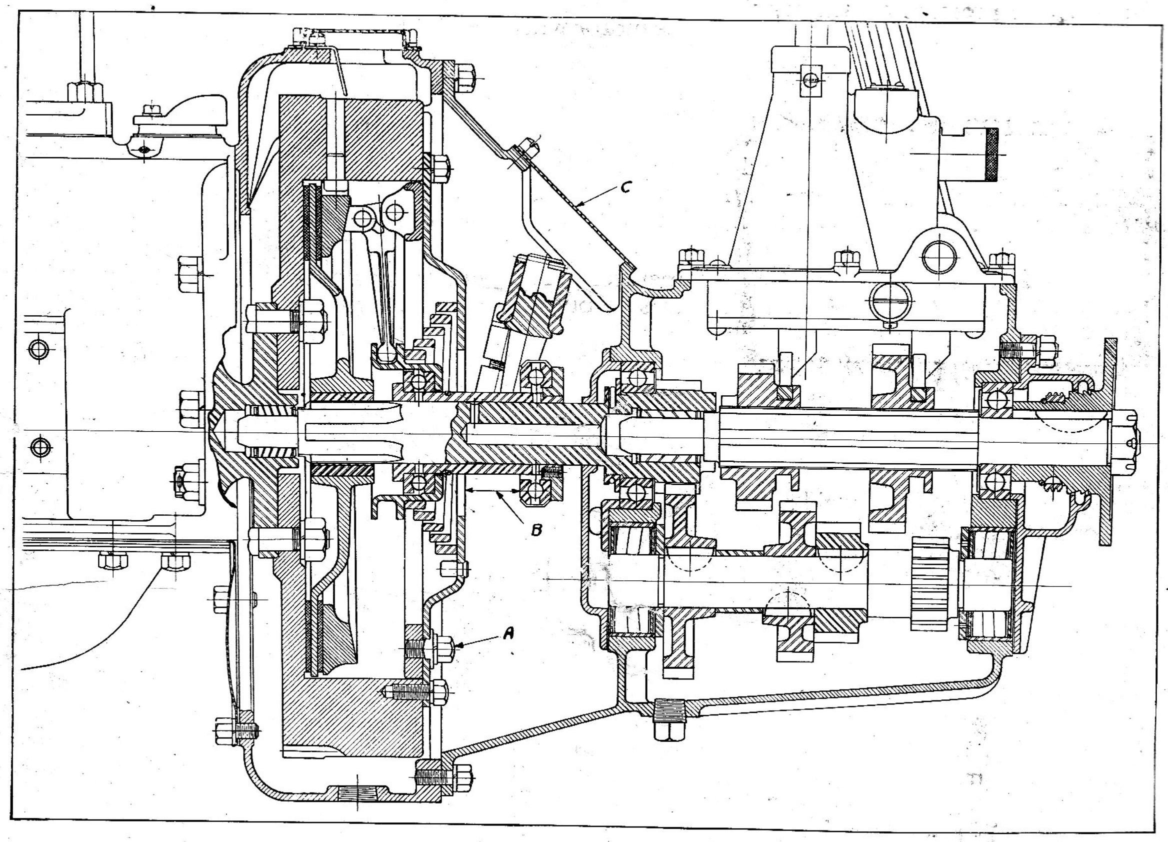


Figure No. 31 SECTIONAL VIEW OF CLUTCH AND TRANSMISSION

which the front end of a horizontal shaft is mounted. The main transmission drive gear is integral with this shaft at its rear end, and the shaft is supported at the gear by a ball bearing mounted at front of the transmission case—the latter being bolted to the housing around the flywheel. A friction disc or dry-plate is keyed to the forward end of the shaft by four splines and rotates between two rings of special frictional material—one of these rings being next to the inner face of the flywheel and the other next to a thrust ring which is keyed to the rim of the flywheel. The rear face of this thrust ring constitutes three inclined planes.

Another ring is attached to the clutch cover by two capscrews which extend into the ring through slots in the cover. Three bell crank levers are attached to the inner or front face of this ring, and each lever carries a thrust shoe opposite the point of its attachment. These levers extend toward the center of the ring where their ends engage a slot in a retr[illegible] collar aft[illegible]

upon a sleeve over the horizontal shaft through the medium of a ball thrust bearing. The rear end of the sleeve is threaded to receive a nut which holds in place another ball thrust bearing against which the pedal leverage is exerted through the medium of a cross shaft and yoke when the clutch is disengaged. A heavy coil spring—conical in shape—is held compressed between a shoulder on the retractor collar and the inside face of the cover, and its pressure is exerted to keep the clutch discs engaged.

The friction disc and rings of frictional material, the horizontal shaft and the sleeve being the only parts not anchored to the flywheel, float at rest until they are locked to the flywheel by the wedge action of the bell cranks. When the clutch pedal is pressed the sleeve and retractor collar are pulled rearward, moving the bell cranks and consequently releasing the wedge pressure on the thrust ring. When released, the spring thrust moves the bell cranks forward exerting the pressure that locks the driving disc. It has been explained that the thrust ring is in the shape of three inclined planes, thinner on the inner edge than on the outer. The thrust shoes on the bell cranks mount this inclined surface as the spring thrust is exerted and gradually increase the pressure on the friction rings. This causes the friction disc to begin to move; at first slowly and then with increasing speed until the pressure of the thrust ring finally locks it to drive with the flywheel.

Adjustment

During the first few hundred miles of service, wear on the friction surfaces of the clutch will be more rapid than during any period thereafter. As wear occurs, the distance in which the wedge action of the thrust shoes takes place is increased, which decreases the distance (B) (Figure 31) between the throwout bearing and the face of the cover plate. As a result the fingers of the throwout yoke are pushed forward and as a slight movement at this point is multiplied at the pedal, the initial clearance between the pedal and the floor board will in time be entirely taken up. The distance in which the spring may exert its pressure being limited by this obstruction, it can no longer hold the friction surfaces in proper contact and slippage with consequent loss of power will naturally result.

There should be a clearance between the pedal (when the clutch is engaged) and the floor board of from ¾" to 1" and the operator should see that this distance is maintained. It can be increased when necessary by a readjustment of the set-screw, which is provided for this purpose at the lower end of the pedal lever as shown in Figure 31. It is simply necessary to release the lock nut and withdraw the set-screw a few turns. The lock nut should then be retightened.

The extent to which the pedal adjustment can be repeated as wear occurs is dependent upon the amount of pressure exerted by the clutch spring (which varies between certain limits) and the condition of the friction discs, but a point will eventually be reached after extensive service, where a readjustment of the clutch proper will become necessary.

By turning the adjustment ring in a clockwise direction at that time the relation of the thrust shoes to the thrust ring will be changed so that the distance in which the wedge action takes place is shortened, and thus the pressure of the spring and the grip on the friction surfaces is increased. The initial adjustment at the factory and any readjustment thereafter is regulated by the distance at (B) when the clutch is engaged, which should be $1\frac{5}{16}$ inches.

To adjust the thrust ring the clutch must be released by pressing the pedal. The two slot-bolts (A) which enter the ring must be brought to the hand hole (C) in the housing, then loosened in turn and the ring moved to the right or clockwise about ½" by tapping upon the heads of either bolt. The clutch should then be engaged and the distance at (B) measured. If this distance is more than $1\frac{5}{16}$", the clutch should again be released and the ring moved in the opposite direction far enough to give the correct setting. The slot-bolts should then be retightened.

An adjustment of the thrust ring will automatically lower the pedal, in other words it will increase the clearance between the pedal and the floor board and where this clearance has been maintained by adjustment of the pedal, it will be found necessary to raise the pedal to a proper distance from the floor board by returning the set-screw to its original setting. Otherwise the "throw" of the pedal may not be sufficient to fully release the clutch and it will tend to drag.

It is intended that when the slot-bolts reach the end of the cover slots due to repeated adjustments, they should be screwed out of their mounting holes and set back into repeat holes at the opposite end of the slots; however, where this is possible it is usually necessary to replace

Figure No.

Dragging and Grabbing

Dragging of the clutch, which makes gear shifting difficult, comes from the failure of the discs to release properly and to allow the driving disc to come to rest. It is usually caused by too tight an adjustment. The remedy in such case is to set back the slot bolts (A) slightly. Grabbing or stuttering causes the car to jump when the clutch is engaged and shows uneven gripping of the driving disc by the friction rings. This is often caused by the accumulation of dirt or grease on the friction rings and can only be corrected by taking the clutch apart and washing the rings.

TRANSMISSION

Explanation

The transmission—so named by its function of transmitting the motive power to the rear axle, directly through its main shaft or through reduction gears when a greater reduction

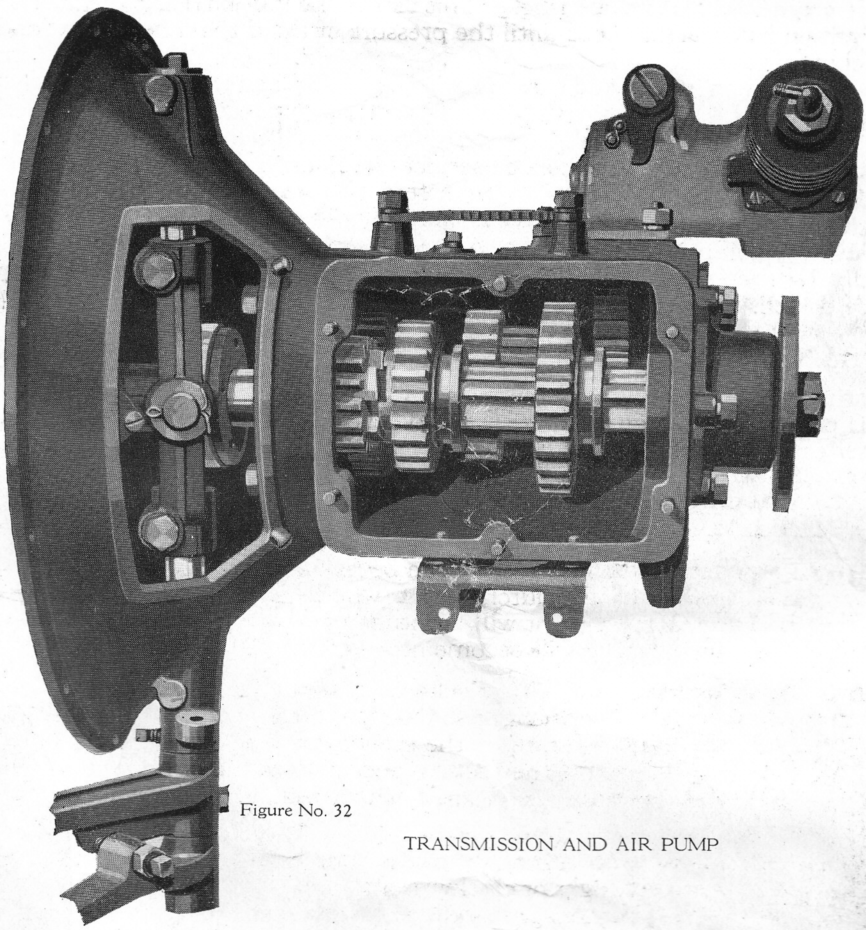


Figure No. 32

TRANSMISSION AND AIR PUMP

between driving and driven units is necessary—is of the selective type with three speeds forward and one reverse speed. It consists of a splined shaft above on which are mounted two sliding gears controlled by the gear shift hand lever. Below this splined shaft is a countershaft on which four additional gears are mounted; a reverse gear, a first speed gear, an intermediate gear and the countershaft drive gear. The latter gear is permanently engaged with the main drive gear on the end of the clutch shaft and causes the countershaft to revolve at all times when the clutch is engaged. The front end of the splined shaft is carried in a roller bearing within the end of the main drive gear and is connected at its rear end to the propeller shaft. The main drive gear and rear end of the splined shaft are carried in ball bearings, while the countershaft is carried in roller bearings. There is also a reverse idler gear mounted o[illegible] shaft [illegible]

a position which permits it to engage with the first and reverse speed sliding gear. This idler gear is permanently engaged with the reverse gear on the countershaft and extends through the side of the case for the operation of the air pump.

Operation

The second and high speed sliding gear is caused to engage the intermediate gear on the countershaft, or its dogs to engage the main drive gear, also the first and reverse speed sliding gear is caused to engage the first speed countershaft gear or the reverse idler gear, as the case may be, by forks forged integral with two shifters which slide forward and backward in guides on the underside of the transmission case cover. These shifters are operated by the change speed hand lever, the lower end of which alternates between slots cut in the sides of the shifters for the engagement of first and reverse speed gears or second and high speed gears as the case may be.

The control mechanism is so constructed that it is an impossibility to mesh more than one set of gears at a time. This is accomplished by the necessity of bringing the gear shift lever to the neutral position before it can be moved across into the slot of the other shifter and by a small hardened steel roller located in a recess between the two shifters, which is forced into a notch in the one by the other when it is moved forward or backward. The one is thereby locked in neutral position when the other is being moved. There are also two pawls entered from the sides of the transmission cover which fall into slots in the sides of the shifters when they are in any one of their three positions. The gears are held engaged thereby until demeshed by the gear shift hand lever.

One of the outstanding features of this transmission is the "Neutral Lock" for the change speed hand lever, which automatically locks that lever at the central or neutral position when pushed forward by the foot. The "Yale" cylinder must be unlocked by the proper key before the car can be driven.

Adjustment

The bearings in the transmission are of a type that do not require adjustment; therefore no adjustment is provided excepting that thrust washers are installed at the ends of the countershaft and after extensive service it may be found necessary to have these replaced.

PROPELLER SHAFT AND UNIVERSAL JOINTS

Explanation

As the motive power is not transmitted to the rear axle in a horizontal plane excepting when the springs are compressed under load it is necessary that the propeller shaft between these units

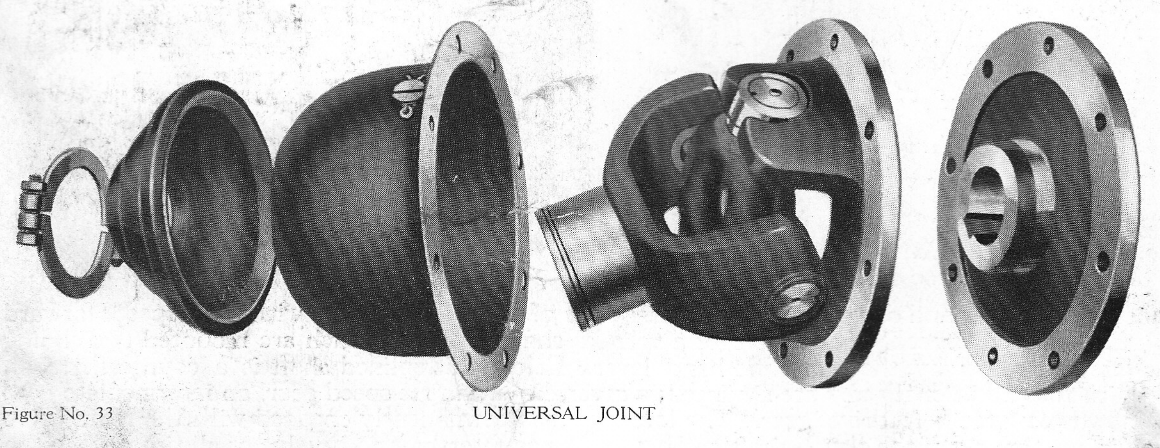


Figure No. 33 UNIVERSAL JOINT

be connected by universal joints. It will be seen that the angularity of the propeller shaft is subject to change by the spring action and that there is also a certain amount of distortion in the [illegible] when the car is travelling over rough or uneven roads which makes flexibility of action necessary at those points. The forward universal joint includes a slip connection which allows

Fig [illegible].

for any variation in the overall length of the set due to spring action. This slip connection consists of a grooved socket which receives the splined end of the shaft and provides for the forward and backward thrust.

Position of Casing

Should it be found necessary to disassemble the universal joints, care should be taken in reassembling to see that the bolt holes in the flange and the inside casing are matched up in such a way as to bring the grease hole which is closed by a threaded plug, opposite an open space in the joint, and not opposite one of the lugs which would prevent the introduction of grease through the hole.

The joints are fitted with a spring of suitable strength to give the proper pressure on the packing between the inner and outer casings in order that the lubricant may be retained. These springs will require no attention from the operator.

Aside from lubrication the universal joints should require no attention excepting possibly that the journal bushings may become worn after extensive service and their replacement found necessary to eliminate lost motion. The packing between the inner and outer casings may also require renewal to prevent loss of the lubricant.

REAR AXLE

Explanation

The rear axle is of the floating type with pressed steel housing and with the driving and driven parts carried as a unit by a removable housing known as the "Differential Carrier." This construction insures perfect alignment of the drive pinion and bevel ring gear through which the power is transmitted to the axle shafts. The axle assembly includes the pinion shaft, differential, axle shafts, brakes and wheels and constitutes the final element in the driving mechanism.

The pinion shaft transmits the power from the propeller shaft to the driving gears of the differential. It is contained within the housing formed by the differential carrier and its front end is carried by a double row ball bearing within an adjustable sleeve threaded into the end of the differential carrier. Its rear end is carried by a roller bearing immediately in front of the bevel pinion. The bearing outer races are prevented from turning in the case of the roller bearing by a set screw entered from the outside of the carrier and in the case of the ball bearing by a nut threaded into the rear end of the adjusting sleeve and secured by a lock wire. These bearings are separated by a spacer and are held between a washer at back of the pinion and an adjusting nut at front end of the shaft. The adjusting nut is locked by a jam nut and locking washer. The pinion shaft with its pinion, bearings, and adjusting sleeve, is removable as a unit by [illegible]oving the locking finger and withdrawing the sleeve.

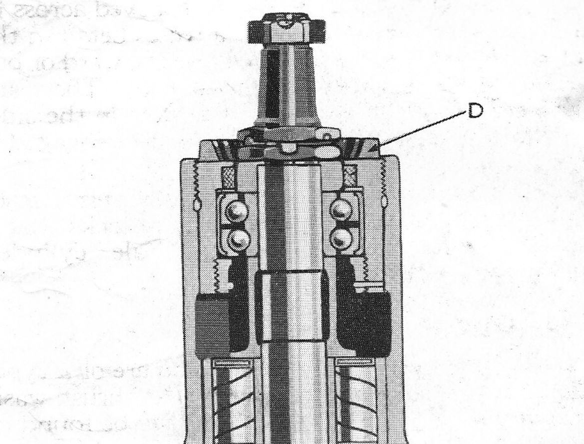


Fig. No. 34 SECTIONAL VIEW OF DIFFERENTIAL CARRIER ASSEMBLY
(Showing Points of Adjustment)

The differential equalizes the amount of power applied to each of the re[illegible] wh[illegible] knu[illegible]

one wheel to travel faster than the other when the car is rounding a curve. It consists of a case mounted upon and held in position between adjustable taper roller bearings. The bevel ring gear which engages the drive pinion is attached to the outside of the differential case. Inside of this case is a set of four bevel pinions, which engage side gears on the splined inner ends of the axle shafts. Ordinarily the differential gears lock themselves and revolve with the case as a solid unit but when rounding a curve the inside wheel tends to pivot and being connected to one of the side gears by the axle shaft causes that gear to revolve more slowly. Since the motor continues to drive the differential case at the same speed the four bevel pinions are caused to revolve, thus allowing the other side gear to revolve at a speed which is increased in proportion to the decrease in speed of the gear on the pivoting side.

The rear wheel driving flanges are keyed to the tapered ends of the axle shafts, and the load is carried by double row ball bearings on the outer ends of the axle tubes. These bearings are contained within the hubs of the wheels and are held therein by retainers. They are held on the axle tubes by locking nuts and washers. The discs on the brake spiders provide troughs into which escaping oil will fall and be carried away by drain pipes.

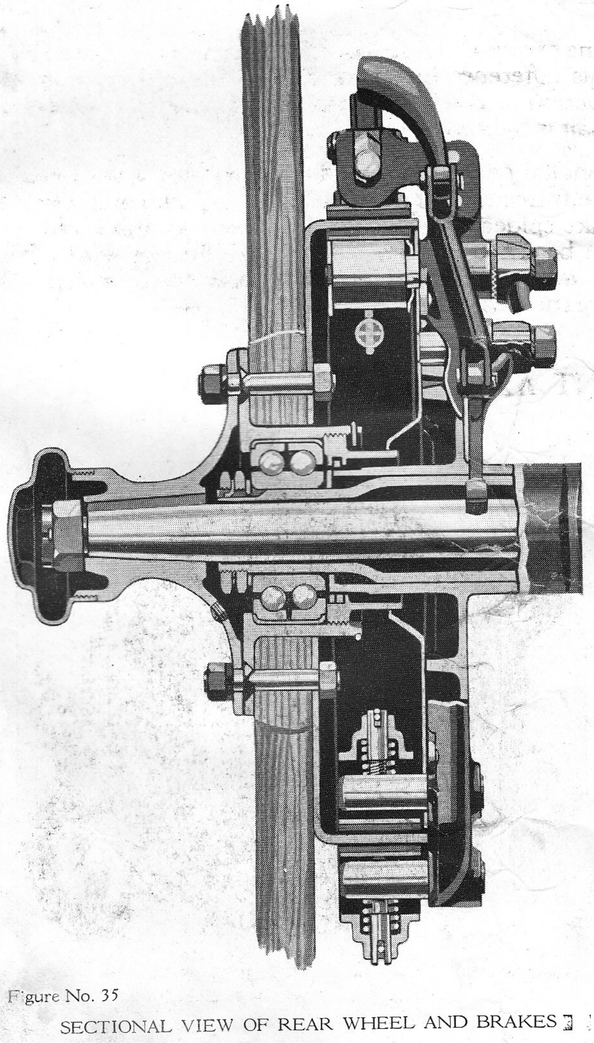


Figure No. 35

SECTIONAL VIEW OF REAR WHEEL AND BRAKES

Adjustment

In order that the spiral bevel ring gear and drive pinion may operate correctly they must be in perfect alignment; at the same time there must be a correct amount of back lash between the pinion and gear. To that end two means of adjustment are provided. The differential on which the ring gear is mounted may be moved toward either side as required by turning one of the adjusting nuts (A) Figure No. 34 to the left and turning the other to the right an equal amount, after the locking fingers (B) have been removed and the screws (C) in the bearing caps have been loosened. The pinion may also be moved forward or backward by turning the adjusting sleeve (D) in which the pinion shaft is mounted. The movement of the pinion shaft adjusting sleeve or the differential adjusting rings one notch is equivalent to approximately four thousandths (.004) inch at the point of contact between the pinion and ring gear. The amount of back lash necessary to insure quietness of action is ordinarily between ten thousandths (.010) and twenty thousandths (.020) of an inch, depending upon the cut of the gears and the variation which takes place in their manufacture. The proper amount of back lash or clearance should be arrived at however, only after it is known that the ends of the teeth on the pinion are flush with either the inner or outer ends of the teeth on the ring gear.

To arrive at the proper running position of these gears—in order that their teeth may have a full line contact and at the sar[illegible] tir[illegible] operate with quietness—is the work of an experienced mechanic who often locates th[illegible] [illegible]ning position only after a number of experimental settings within certain limits. Th[illegible] should not be attempted by the average operator, notwithstanding the fact that [illegible] amount of mechanical knowledge and ability.

Brakes

There are two brakes for each rear wheel, the external or contracting brakes known as the service brakes, and the internal or expanding brakes known as the emergency brakes. The former are linked to and controlled by the foot pedal, while the latter are operated by a hand lever within easy reach from the driver's seat. The brake bands are supported by studs riveted to the brake spiders, which are securely riveted in turn to the ends of the axle tubes. Steel discs are attached to the spiders to exclude dirt from the internal brakes.

There are four points of adjustment on each set of brakes. The adjusting screws (A) and (B) Figure No. 36 are the means of providing the proper clearance at rear of the internal and external bands when released and should be adjusted to allow an opening between the brake drum and the linings on the brake bands of not more than 1/32 inch. The adjusting nuts (C) which control the setting of the lower halves of the external bands are next to receive attention in the proper order of adjustment. The jam nuts must be loosened and the adjusting nuts regulated to give a maximum clearance of 1/32 inch around the lower halves of the bands. Should the linings touch the drums at any point due to their not being a true circle, a screw driver should be inserted and the band forced away. When the adjusting nuts are properly regulated they should be relocked by the jam nuts.

The clearance between the top halves of the external bands should be regulated to a maximum of 1/16 inch by means of the nuts (D). This difference in clearance of 1/32 inch between the upper and lower halves is necessary by the action of the bell cranks, which tend to tighten the upper half to the drum sooner than the lower half is tightened.

When the brakes are released the pedal should be close to the floor board and the centers of the eyes of all levers on the cross shafts in the frame should be from 1" to 1¼ inches to the rear of the shafts. The levers carried on the brake spiders should be as far back as allowable with the rods furnished and these rods should not be shortened when the brake linings wear. This would disturb the proper setting of the brake levers and would prevent proper brake action. All adjustments should be made at the bands where the wear occurs.

FRONT AXLE

Explanation

The front axle I-beam center, steering knuckles and steering arms are drop forgings of carbon steel, suitably heat treated. Two hardened steel thrust washers are provided between the axle yokes and tops of the steering knuckles. The king bolts which secure the knuckles to the axle are pinned to the latter and are mounted in hardened steel bushings at their upper and lower ends. Each bushing is provided with an oiler. The tapered ends of the steering arms are keyed to the knuckles and are secured by castle nuts and cotter keys. The tie rod yokes are drop forged, heat treated, and secured to the steering arms by hardened steel bolts mounted in steel bushings at their upper and lower ends. These bolts are also provided with oilers.

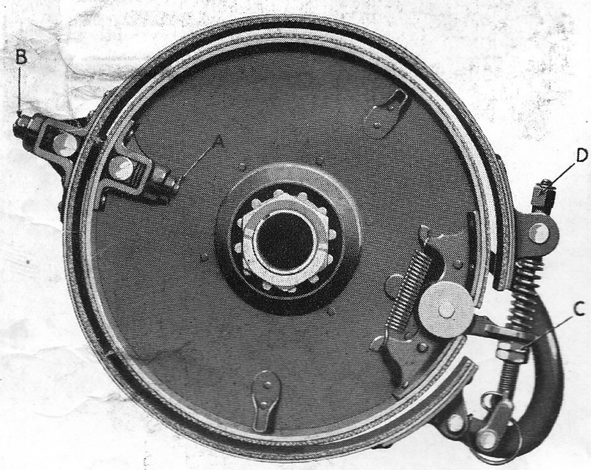


Figure No. 36 REAR WHEEL BRAKES
(Showing Points of Adjustment)

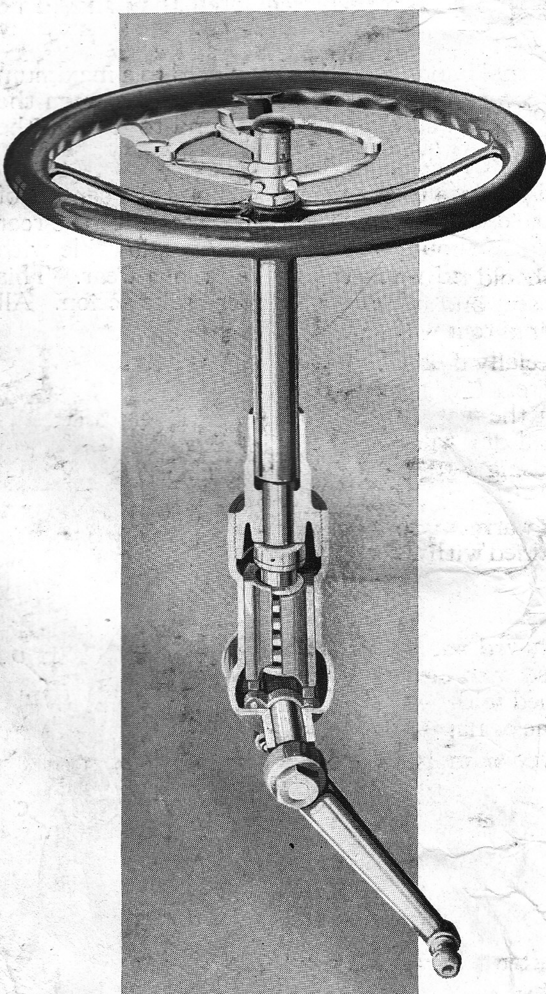
The front wheels are mounted on tapered roller bearings and are secured by lock washers, castle nuts and cotter keys. The bearings are protected from dust by felt washers and retainers at the inside of the wheel hubs, and by the hub caps on the axle shaft flange. The bushings for the stee[illegible] knuckle bolts are also protected by dust caps. The tie rod between the steering arm[illegible] the rear of the axle where it is protected from accident. All bearing surfaces are ground a[illegible] to size and held within strict limits. Adjustable stops regulate the throw of the [illegible] knuckles

Adjustment

Attention is called to the fact that the front wheels have a gather, or are "toed-in" approximately 5/16 of an inch. Difficult steering and excessive wear on the front wheel tires are often caused by a change in this setting, the result possibly of an accident. The measurement should be taken front and rear at the felloe band, and in a horizontal plane through the center of the wheels. It should be found that they are closer in front than in the rear by the above given amount. An adjustment can be made if necessary by means of the adjustable yoke on the tie rod between the steering knuckle arms.

Wheel Bearings

To adjust the roller bearings in the front wheels to compensate for wear, the wheels should be relieved of their load by raising the axle. Having removed the hub cap and cotter pin, the adjusting nut on the end of the spindle should be turned against the inner cone of the outer bearing while the wheel is being rotated. When the wheel binds the nut should be backed away just enough to allow the wheel to rotate freely without any perceptable shake or end play. At that point the nut should be relocked.



No. 37
SECTIONAL VIEW OF STEERING GEAR

The double row ball bearings in the rear wheels should require little or no adjustment, excepting that the adjusting nuts on the ends of the axle tubes should press tightly against the inner races of the bearings at all times, and that they should be securely locked. To reach the adjusting nuts, the axle shaft driving flanges must be unfastened and the axle shafts withdrawn from the tubes. It is important that the bearing retainer is fully screwed up and securely locked by the locking wire, when the bearing is returned to the wheel hub after having been removed.

Once or twice during a season the bearings should be removed and washed in a mixture of washing soda and hot water. They should be placed in a pan containing the solution and heated over a fire until the boiling point is reached. This will cleanse them of hardened grease and injurious foreign matter. Having been thoroughly cleaned and dried, they should be well packed with clean cup grease and remounted after the inside of the wheel hub and the spindle have been cleaned with gasoline or kerosene applied with a stiff brush.

STEERING GEAR

Explanation

The principal parts of the steering gear are the steering screw, a right and left handed half-nut, a rocker shaft, a ball thrust bearing, an adjustable screw and a case or housing. The steering screw has a right and left handed thread which cross each other at each half turn, and of the proper shape to mate with the "Buttress" form of thread in the half-nuts. Turning the hand wheel rotates the tube in the [illegible] to which the screw is keyed, and as the screw rotates it causes the half-nuts to slide in opposite directions. The lower ends of these nuts rest on rollers and operate a rocker-shaft to which is fitted the pitman arm and reach rod connecting it to the knuckle arm on the front axle.

Uniformity of action is obtained by a true parallelogram of forces acting within the gear. The forward thrust of the nuts is taken up by the two hardened rollers located equidistant from and in the same plane as the axis of the rocker-shaft. These roll on the flat face of a hardened thrust block attached to the end of each half-nut, which face lies in a plane perpendicular to the axis of the screw. The power of the gear to deliver energy to the link which connects it to the road wheels is practically equal throughout its travel, as the triangle formed by the line of screw thrust and the plane cutting through the axis of the shaft and rollers is balanced by that formed by the Pitman arm and its link.

Adjustment

After prolonged service, an excessive amount of play or lost motion may develop in the steering gear due to wear on the threads of the half-nuts. However, before readjustment is made of the gear it should be known that the lost motion is not at some other point in the steering mechanism, such as might develop at the reach rod ball sockets, steering knuckle bolts, etc. Lost motion in the gear proper can be reduced by loosening the clamp at top of the gear housing and turning the nut, Figure No. 37, to the right until the remaining amount of play in the wheel is satisfactory. The clamp should then be retightened.

Care of Body

If the owner takes pride in the appearance of his car and wishes to maintain the original lustre of the body finish as long as possible, he should remove mud or grease as soon as possible, and in so doing should use clear water only, excepting that in cases where it is necessary to remove grease, pure castile soap may be used. Ordinarily, it should not be necessary to use soap in cleaning and special attention is called to the fact that alkali soap or gasoline is ruinous to the body finish.

When water from a hose is used, the nozzle should be removed and the water flowed gently upon the body. A piece of cloth should not be used, and it should be remembered when using a sponge that every particle of grit or sand which clings to it will scratch the varnish.

Extremely warm or cold water is harmful, especially if used where there is any great difference between its temperature and that of the atmosphere. It is recommended that the car be washed in a warm garage during winter months, and that the water have a temperature of about 60 to 70 degrees Fahrenheit. The body should be wiped dry with a clean chamois skin. Otherwise, the varnish will appear cloudy and streaked. In using a chamois skin, care should also be taken to prevent scratching.

The chassis and wheels may be washed with warm water and castile or ivory soap applied with a soft sponge. They may then be thoroughly dried with a chamois skin.

Care of Top

When the top is cleaned, dust should be removed with a dry brush and it should then be washed with warm water and castile soap. Rinse with clear warm water and dry with a soft cloth. The underside of the top should be cleaned with a stiff brush and grease spots can be removed with soap and water. Do not use gasoline or naptha as they are injurious to the fabric.

The top should never be folded when it is wet or moist, and when folding, care should be taken to prevent "pinching" or "bunching."

Tire Hints

Keep tires fully inflated.
Turn corners slowly.
Use plenty of soapstone inside of casings.
Have casings vulcanized as soon as possible after a blow-out, or when cut.
Keep extra tires in a cool, dark and dry place.
If car is stored, jack up all four wheels and deflate tires one half.
Keep tires free from oil and grease.
Watch ahead for sharp objects when driving, especially during rainy weather.

Headlamp Adjustment

The position of the headlamps can be regulated to any position [illegible] the anchor bolts which pass through the brackets.

LUBRICATION

Explanation

Too much attention cannot be given to the subject of intelligent lubrication, as the life of an automotive vehicle depends to the greatest extent upon the quantity and quality of lubricants used. Extensive and costly repairs can be avoided by conscientious attention to this most important feature. Attention is called to the care a railway locomotive receives from its crew and from those others whose duty it is to keep that masive machinery in a proper state of repair. You are assured that if given only a part of the same care, a Paige car will return unlimited service and satisfaction.

Motor

Special attention should be given to the selection of cylinder oil for use in the motor. Oil produced by reputable manufacturers and of the proper grade only should be used. Care should be taken to see that it is free from acid, grit and other ingredients, which would be harmful to the finely polished and closely fitting bearing surfaces throughout the motor.

At intervals of about 500 miles during the first 2000 miles of travel the drain plug underneath the reservoir should be unscrewed, the old oil drained and fresh oil supplied. After that time this will be necessary at 1000 mile intervals only. Once or twice during a season the oil reservoir should be removed and thoroughly cleaned with gasoline to remove any sediment or foreign matter which may have entered with the oil.

Since the inception of the automotive industry and until the last few years most recommendation charts have been based on the principle of different motor oils for summer and winter use. However, with the advent of the low grades of gasoline now in use, it has been necessary to combat the effect of condensation in the combustion chambers upon the lubricating oil in the crankcase, and in addition to draining the old oil and replacing it with new every 500 miles during cold weather, it is recommended that a medium grade of oil be used for the first 10,000 miles during the summer and winter months; the reason being that the leakage of gasoline past the piston rings and into the crankcase has a greater effect upon the diluting or thinning of the oil in cold weather than in warm, due to the fact that the engine temperature being lower in the winter less of the gasoline in the crankcase will be thrown off or evaporated, and hence a greater amount of this gasoline will be absorbed by the motor oil, making the used oil even thinner in winter than in summer during the same period of operation.

If a thinner oil is placed in the motor in cold weather to facilitate starting this oil will become too thin under operating temperatures and conditions to properly lubricate the motor parts, The lubricating oil will also be too thin to produce the proper seal on the piston rings, thereby further increasing the gasoline leakage and resulting in increased gasoline consumption per mile as well as decreased lubricating efficiency of the motor.

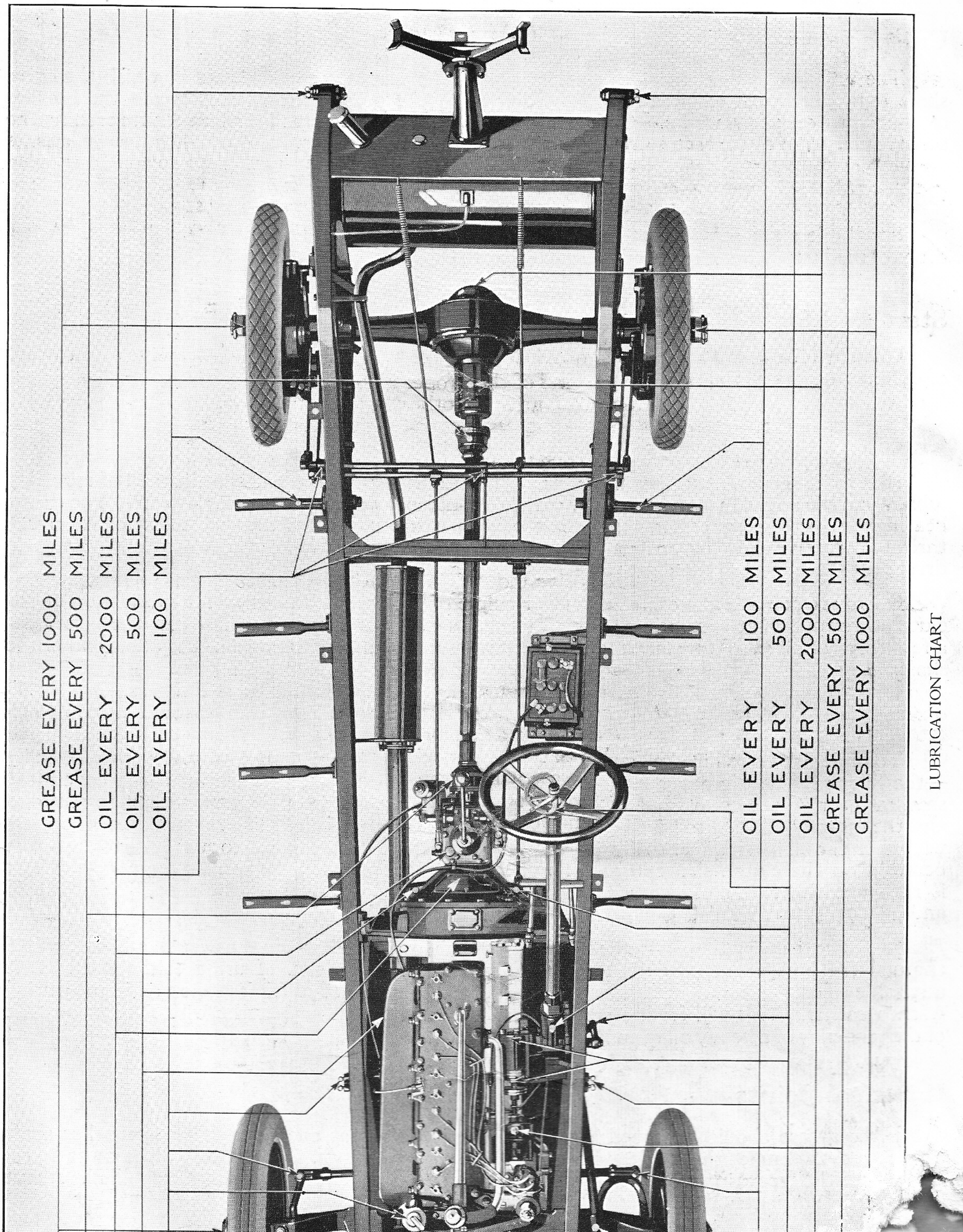
After the first 10,000 miles a heavy grade of oil should be used in both warm and cold weather, as the lighter grade of oil will not properly seal the piston rings after they have become worn by that amount of service. When the motor is thoroughly overhauled (cylinders rebored, oversize pistons and rings fitted) so that it is placed in the condition of a new motor, the grade of oil recommended for use during the first 10,000 miles should again be used.

Water Pump

A large compression grease cup has been provided for lubrication of the drive shaft bushings [illegible] water pump. It should be filled with cup grease about every 500 miles of travel and given [illegible]plete turn each day.

[illegible]

[illegible] ction [illegible] which is [illegible]ted the [illegible]ug in the hub of the fan should be removed about every 500 miles [illegible] ylinder oil such as 600-W.



LUBRICATION CHART

Unisparker

The unisparker shaft receives sufficient lubrication from the crank case in which the drive shaft is mounted. A small amount of vaseline should be applied to the cam in the breaker mechanism every few weeks. Care must be taken to prevent this lubricant from reaching the contact points. The contact maker base should be clean at all times.

Generator

Small oilers are provided at each end of the generator over the armature bearings. A few drops of medium cylinder oil should be entered into those cups about every 500 miles.

Starting Motor

Oilers will be found at each end of the starting motor which should also receive a few drops of cylinder oil every 500 miles.

Clutch

It is to be remembered that the clutch is of the dry plate type and that instead of requiring lubrication the opposite is true, as oil or grease on the discs will cause the clutch to slip. The thrust bearing for the retractor collar, the sleeve on which it is mounted and the thrust bearing for clutch throwout receive lubrication from the transmission through a passage at center of the main drive gear shaft and will therefore require no attention.

Oilers are provided at each side of the transmission case bell housing for lubrication of the clutch throwout shaft bearings. They should be filled about every 500 miles. At the same time a few drops of oil should be inserted between the clutch and brake pedals at the outer end of the shaft.

Transmission

To replenish the oil in the transmission case—which will be necessary about every 2000 miles —the filler plug in the cover must be removed and the case filled to a level which covers the smallest gear on the countershaft. A pipe plug in the right side of the case should be removed and the oil only allowed to reach the level established by that hole. The revolution of the gears will churn the oil in a manner to lubricate all parts of the transmission and to supply oil to the thrust bearings on the clutch sleeve through the passage at center of the main drive gear shaft. It is recommended that a good grade of steam cylinder oil, such as 600-W, be used, free from acid and grit.

About once every three months or approximately every 4000 miles the case should be drained through the hole provided at bottom and flushed with kerosene. During cold weather it is advisable to add an equal amount of light cylinder oil to the heavy transmission oil in use during warm weather. This will facilitate shifting of the gears which might otherwise stick as a result of the tendency of a heavy oil to congeal in cold weather.

Universal Joints

Fibre grease should be forced into the universal joints at each end of the propeller shaft [illegible]ut every 500 miles through the holes provided in the casings. The slotted plugs must be re-[illegible]ed and the grease injected with a grease gun. The casings should not be entirely filled. About [illegible] is sufficient.

[illegible]e

[illegible] once [illegible]y three months or approximately every 4000 miles the drain plug at bottom [illegible] re[illegible]ing should be removed, the old oil drained and the case flushed with which [illegible] [illegible]e hole in the cover. The housing should then be refilled with a good [illegible]00 [illegible] oil. The oil level is established by the filling hole in the cover.

The oil level in the axle should be verified about every 2000 miles. At that time the pipe plug at top of the pinion shaft housing should be removed and a small quantity of oil supplied at that point for lubrication of the bearings on the shaft.

Front Axle

The oil cups at the upper and lower ends of the steering knuckle pins, and at top of the yoke pins at each end of the steering knuckle tie rod should be filled about every 100 miles with cylinder oil.

Steering Gear

When the steering gear leaves the factory it is filled with a heavy graphite grease. This grease is forced through the entire length of the telescoping tubes under heavy pressure and it is expected that the supply will be sufficient for an indefinite period. This grease may require thinning, however, the frequency being governed by the temperature. In any event it would be advisable to insert a small quantity of 600 W; Steam Cylinder oil through the hole in the gear housing about every 2000 miles. The ball oiler at the hub of the steering wheel should also receive a few drops of oil about every 500 miles.

The bearings for the yoke or cradle shaft, to which the arm is attached, are self lubricated and will require no attention. The ball sockets at each end of the reach rod are provided with grease cups which should be filled about every 500 miles and given a complete turn each day.

Springs

All spring shackle bolts are equipped with dust proof oilers which should be filled about every 100 miles with cylinder oil.

Wheel Bearings

The front wheel hub caps should be packed with soft grease about every 1000 miles. At the same time the slotted plugs in rear wheel driving flanges should be unscrewed and grease injected into the double row ball bearings within the hubs. It will be necessary to use a grease gun for this purpose.

Common Difficulties

MOTOR FAILS TO START

Gasoline supply exhausted.
Tube from tank to vacuum tank stopped up.
Dirt or sediment in vacuum system.
Water or dirt in gasoline.
Carburetor flooded.
Carburetor improperly adjusted.
Short circuit in switch.
Disconnected wire terminal.
Battery exhausted.
Starter switch not making contact.
Short circuit in wiring system.
Improper contact at wire terminals.
Oil or grease on unisparker contact points.
Spark plug points improperly spaced.
Motor cold.

MOTOR MISSES

Unisparker points dirty or improperly adjusted.
Ignition cables broken.
Loose cable terminals.
Cable insulation worn causing short circuit.
Spark plugs dirty or broken.
Spark plug points improperly spaced.
Gasoline mixture too rich or lean.
Water or dirt in gasoline.
Carburetor improperly adjusted.
Valve tappets improperly adjusted.
Motor badly carbonized.
Loss of compression.
Motor cold.

SLIPPING CLUTCH

Pedal striking floor board.
Oil on discs.
[illegible]utch improperly adjusted.
[illegible]s worn out.

CLUTCH DRAGGING

[illegible]lly [illegible]ase.
[illegible] adjusted.
[illegible]

BACK FIRING

Gasoline mixture too lean.
Water in gasoline.
Inlet valves not seating.
Improper spark timing.
Motor carbonized.
Motor missing.

OVERHEATING

Lack of water.
Lack of lubrication.
Spark not sufficiently advanced.
Gasoline mixture too rich.
Loose fan belt.
Dragging brakes.
Slipping Clutch
Use of anti-freeze in warm weather.
Cylinders carbonized.
Accumulation of scale or rust in cooling system.
Partial stoppage of passages due to disintegrating hose connections.

KNOCKING

Spark too far advanced.
Loose bearings.
Badly overheated.
Cylinders carbonized.
Spark improperly timed.

TRANSMISSION GEARS CLASH

Motor running too fast.
Clutch does not fully release.
Oil congealed in transmission.

BRAKES DRAG OR SLIP

Oil on linings.
Pedal throw improperly adjusted.
Brake bands improperly adjusted.
Linings worn out.

Suggestions

Never allow yourself to be so busy that proper lubrication is neglected, or refilling of radiator forgotten.

When motor is running improperly, investigate immediately and make necessary adjustment or repair.

Do not allow the motor to "labor" and "knock" when ascending a grade. Remember it is no disgrace to shift into a lower gear and it will save the motor.

Know that the storage battery is properly filled with distilled water at all times.

Do not turn corners at high speed. It is a dangerous practice, and if you will not consider your own life and the safety of your car, you must consider the lives and property of others.

When descending a grade with clutch disengaged, do not re-engage it until the motor is accelerated, or the car allowed to slow down. Unless the motor is running at a speed equivalent to the road speed of the car, a great strain will be placed on the mechanism when the clutch is engaged.

When cranking the motor by hand, do not fail to retard the spark lever and pull upward on the crank. Never downward. You may have practiced this without injury, but at some time your arm may be broken.

Do not fail to set hand brake nor turn off the ignition switch when leaving car standing; and do not fail to release brake when starting.

It is a very dangerous practice to inspect any part of the car with a lighted match.

It is dangerous to run the engine in a closed garage, and although windows may be open, it is far safer, particularly if an adjustment of the carburetor is being made, to run the car into the open.

Carbon monoxide, a deadly poisonous gas, is present in the exhaust of gasoline engines. Increasing the proportions of gasoline to air in the mixture fed to the engines, in other words, enriching it, increases the amount of carbon monoxide given off at the exhaust pipe.

Serious personal injury may be caused by the presence of carbon monoxide in a ga[illegible] if the percentage of it in the air is greater than a very small fraction of one per cent. Unconsc[illegible] ness may result without warning. It is reported that no indication of danger is given by [illegible] discomfiture until too late. Deaths resulting from the presence of carbon monoxide [illegible] have been reported.